THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 18 NOVEMBER, 1939 Number 11

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1848–1936

For story, see page 443

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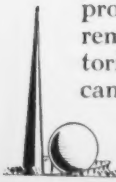

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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

Volume 18 **November, 1939** **Number 11**

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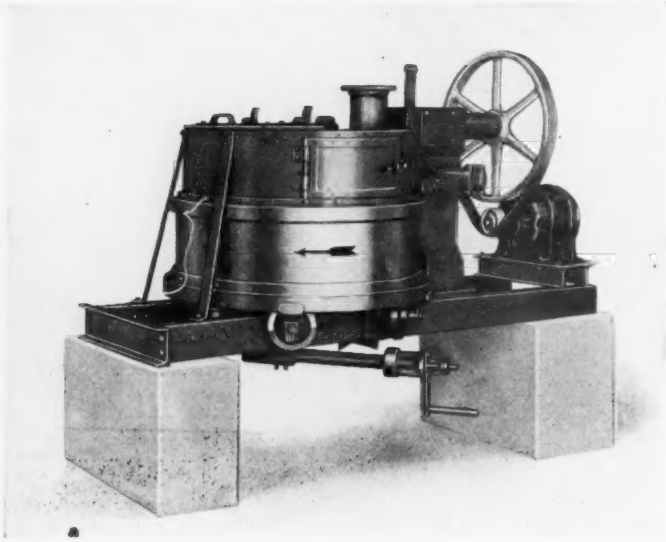

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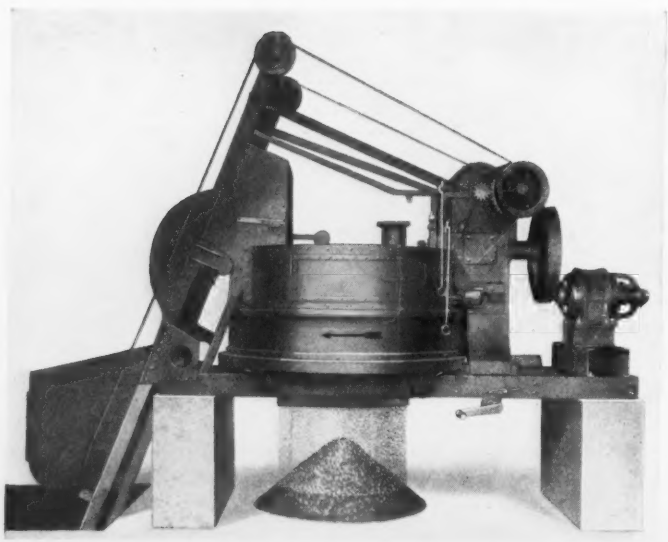

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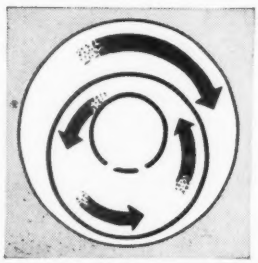

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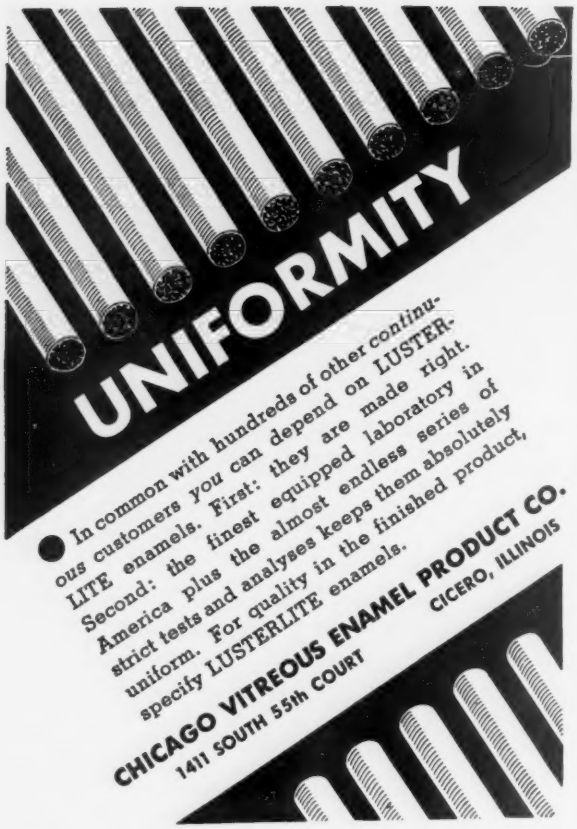
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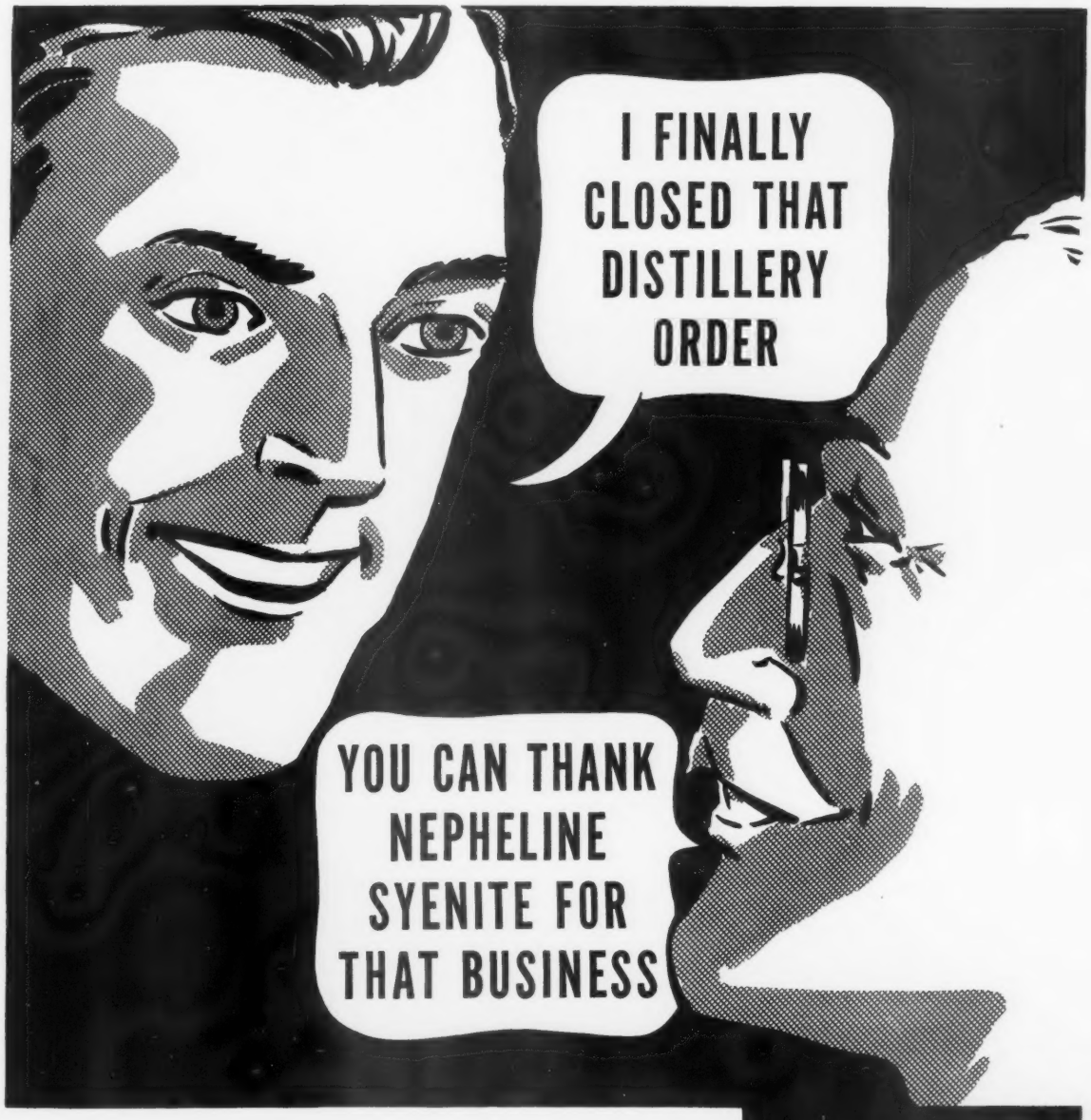

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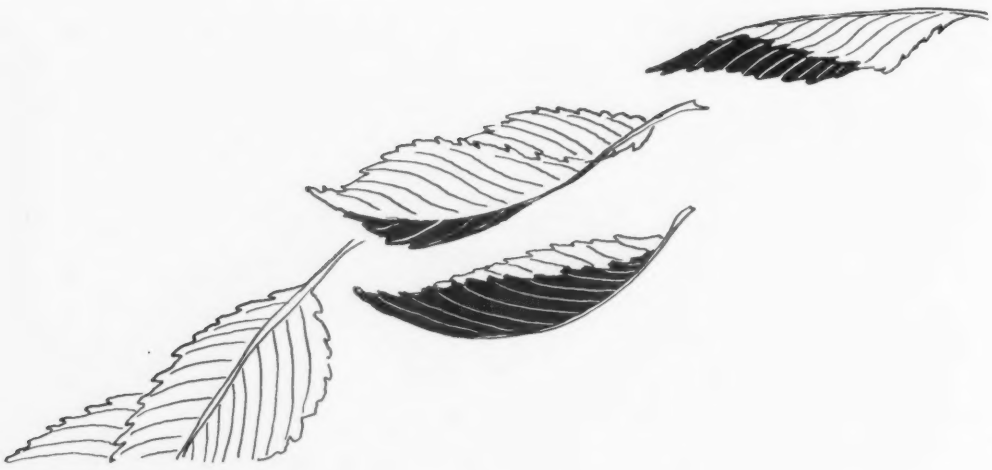

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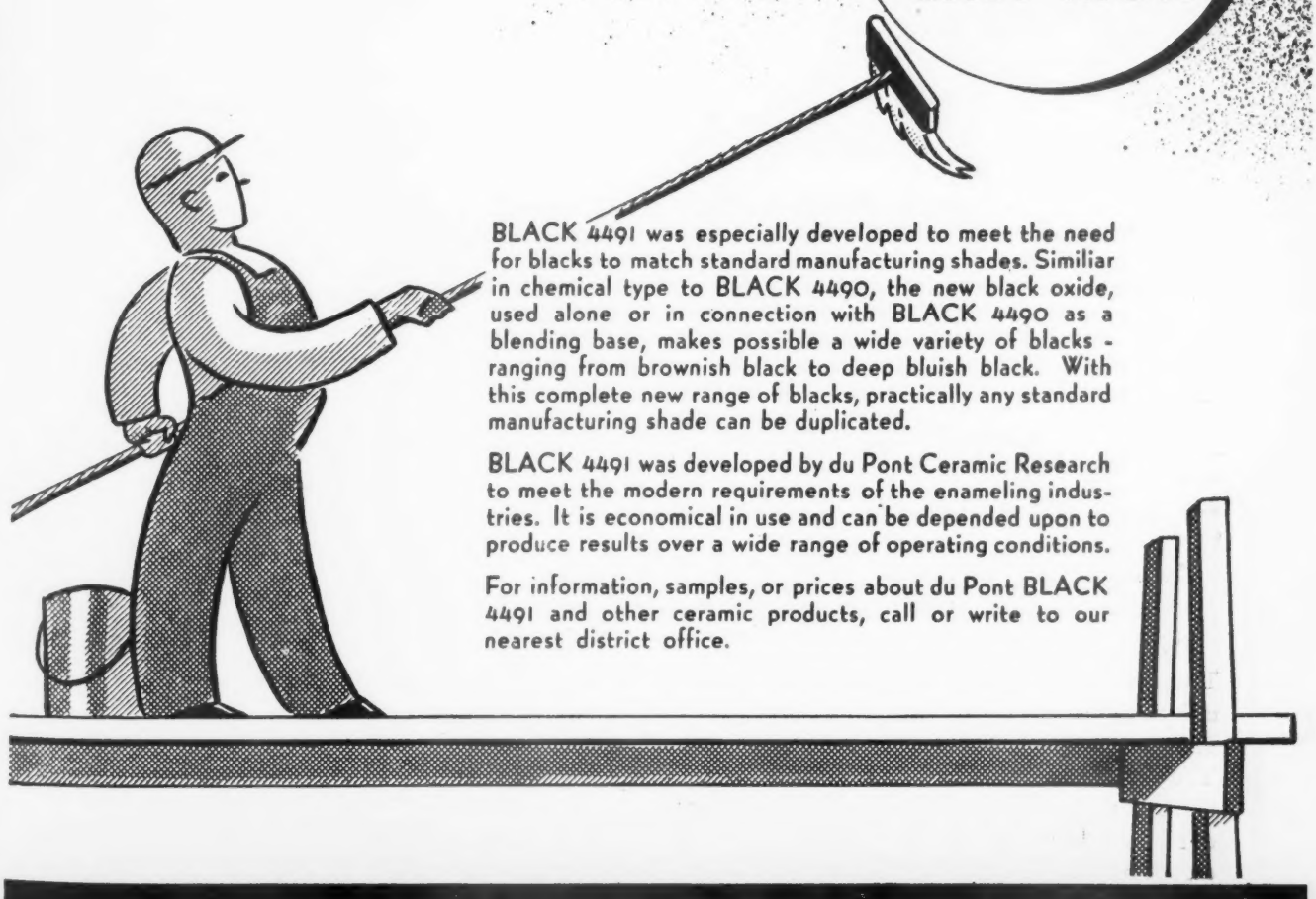

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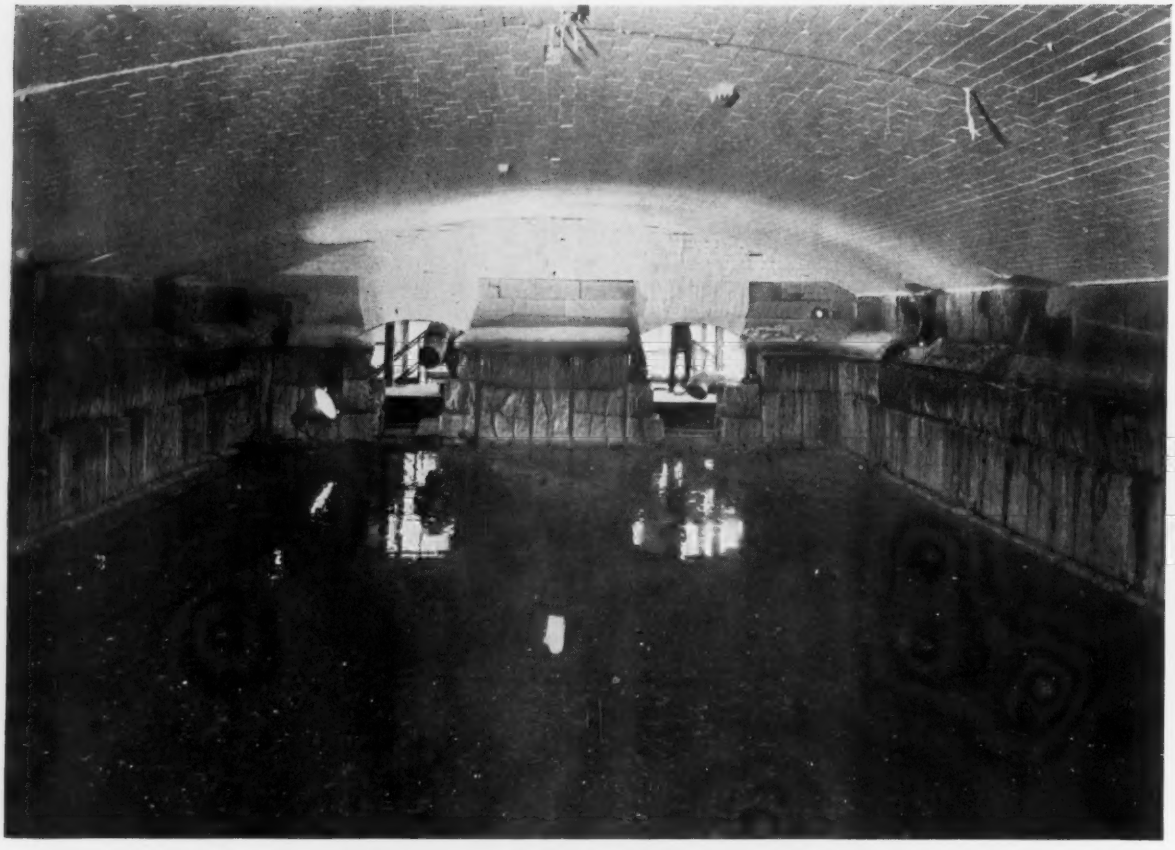

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Volume 18 NOVEMBER, 1939 Number 11

PAPERS

SYMPOSIUM ON "IMPORTANCE OF THERMAL HISTORY"*

I. PROBLEMS OF FIRING CERAMIC WARE IN TUNNEL KILNS†

By Philip Dressler

Abstract

The builder of tunnel kilns from the earliest days has faced the dual problem of securing control of the heat distribution from end to end of the kiln and also through its cross section. Lack of this control has prevented the realization of maximum speed and uniformity of firing which the tunnel kiln theoretically should produce. Recent developments have finally solved simultaneously these two interrelated problems. The methods used to achieve the desired results are discussed.

I. Introduction

When the installation of a tunnel kiln is contemplated, there are usually two particular points of consideration, viz., (1) economies in fuel, labor, and saggers and (2) production of better ware under better control. The first point will not be discussed here because in rare instances only have the economies realized by a tunnel-kiln installation been disappointing. Many papers, moreover, have been presented to this Society with data on tunnel-kiln economics. The production of better ware under controlled conditions has not been equally well realized. Many tunnel-kiln installations have been disappointing from the standpoint of control and of the quality and uniformity of the ware produced. It has been a long and arduous task, in fact, to bring this method of continuous firing to a point where satisfactory results may be expected with certainty.

II. Control of Temperature Distribution

In view of the small cross section of a tunnel kiln in comparison with the volume of an intermittent kiln, it is surprising that the control of temperature distribution, both in the kiln length and cross section, has been so difficult to secure. A brief review of the conditions, however, will make this easier to comprehend.

The early tunnel-kiln designers were confronted with three main control problems, viz., (1) to maintain a constant temperature in the firing zone, (2) to secure an even distribution of heat at the maximum temperature, and (3) to secure control of the temperature curve between the ends of the kiln and the point of maximum temperature with uniform temperatures throughout the cross section at every stage.

(1) Constant Temperature in Firing Zone

The only means of the early tunnel-kiln builder to measure temperature was the judgment of the fireman and what could be ascertained by draw trials. The difficult task of maintaining constant temperatures before the days of pyrometry is easily understood, and it is not remarkable that satisfactory commercial kilns did not appear on the market until pyrometry came into general use. The use of gas and oil burners, instead of the original coal-fired furnaces with which tunnel kilns were equipped (a development more or less simultaneous with that of pyrometry), also helped to secure the control necessary to maintain constant temperatures. Tunnel kilns, by 1910, could be operated to give a maximum temperature which could be controlled to maintain a reasonably constant final fire.

* The papers included in this Symposium were presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 17, 1939. George A. Bole of the Edward Orton, Jr., Ceramic Foundation, Columbus, Ohio, was Chairman. Papers by Philip Dressler, Woldemar Weyl, and E. H. Fritz and H. C. Harrison are presented in this issue; papers by Ralston Russell, Jr., and John H. Koenig will appear later.

† Received June 14, 1939.

(2) Even Heat Distribution at Maximum Temperature

The second problem, namely, that of distributing the temperature evenly throughout the cross section at the maximum temperature, was a little more difficult. It was solved by the following means: (1) better location of the burners, (2) using the velocity of the stream of products of combustion from the burner to reach the center of the setting, and (3) longer zones of maximum temperature, that is, soaking. The cones developed by Seger were invaluable for evening the distribution of heat. These cones could be placed among the ware throughout the cross section of the car, and the firing results in different portions could be checked when the ware was unloaded. By a process of trial and error, adjustments thus could be made to give a satisfactory cone deformation throughout the mass of the ware.

(3) Control of Preheating Zone Curve and Temperature Distribution

Although the cones show the final distribution of the fire, they tell nothing of what happened between the entrance end and the point of maximum temperature. Especially with vitrified ware and heavy clay products, the thermal history in the preheating zone between the entrance of the kiln and the zone of maximum temperature is important in determining a final satisfactory result.

The bottom of tunnel-kiln loads, especially the bottom center, has a tendency to lag behind the top of the ware in the preheating section of the kiln so that the thermal histories of the upper and lower parts of the load differ greatly from each other.

Just why this is true is not difficult to understand. A tunnel kiln may be regarded as a stack laid on its side. A vertical stack will have a reasonably uniform distribution of temperature throughout its cross section and there will be no appreciable amount of stratification of the gases passing through it so that the temperatures throughout the cross section at any particular point in the height of the stack will not differ appreciably from each other. Such a stack, from this standpoint, would form an excellent kiln, and, except for the mechanical difficulties imposed in conveying a load vertically at ceramic firing temperatures, this system would seem to be ideal for continuous firing.

As soon as the stack is turned on its side and lies horizontally, an entirely different condition appears. The gases no longer travel in a uniform stream through the cross section, and a marked stratification takes place with a stream of hot gases flowing through the upper part of the cross section. Even if the products of combustion are introduced in such a way as to enter on the under side of the stack at the hottest portion and so produce a local area of even heat, as they progress toward the discharge of the stack and lose temperature, their volume becomes less and less and the area occupied by the gases becomes smaller and smaller.

A tunnel-kiln designer likes a diagram such as Fig. 1 to show the movement of gases from the fire zone to the entrance end. Figure 1 represents a sectional elevation of the firing space in the kiln between the entrance end and the high fire zone. Such a diagram is an example of "arrow engineering," in which the wish is father to the thought. The gases, unfortunately, are well endowed with the quality of innate cussedness, which is the attribute of inanimate matter, and rather than follow the arrows on the diagram they insist on pursuing the path of least resistance. This path is shown in Fig. 2, on which the temperature curves for the top and bottom of the loads are also indicated.

FIG. 1.

It is not practical to operate a tunnel kiln in such a way that there is no space between the loads and the side walls and crown of the kiln. Circulation spaces in the load itself are also necessary to produce an even fire in the furnace zone, so that straight paths of travel through the kiln are inevitably present. The tendency of the gases is to pass from the firing zone all the way to the entrance in the upper portion of the kiln hugging the crown, where they occupy a decreasing area as they lose temperature; at the entrance, just inside the door, they pass downward to the bottom and become mixed with a stream of cool air coming from leakages around the door and trackage, producing a cold, inward-moving stream which keeps the temperature of the bottoms of the load depressed for a considerable distance into the kiln.

The result is to produce excessively high temperatures in the upper part of the load at the entrance end and at the same time a much shorter period of oxidation for the bottom of the loads than for the top (Fig. 2).

III. Correction Attempts

(1) Long Kilns

To overcome the first condition, longer kilns have been built, and it is this practice that has led to the frequent statement that "tunnel kilns cannot be built too long." At the same time, the output of the kiln is restricted by the fact that for a considerable portion of the preheating zone the bottoms make little progress and then advance rapidly through intermediate temperatures to the maximum. This is the limiting factor in many cases to the speed of operation of a kiln which could operate on much faster cycles if all the ware received the same treatment as the top of the loads.

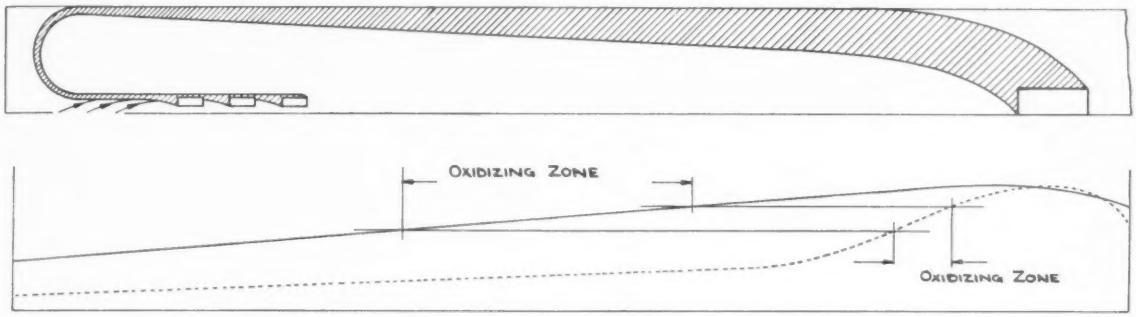
(2) Increase in Number of Burners

As tunnel kilns developed, the short period of maximum temperature given by one burner on each side was found to be inadequate, especially when the more concentrated fuels, such as oil and natural gas, were used. Still keeping to the idea of furnaces or fireboxes, these were multiplied so that, instead of one on each side, two, three, four and even as many as six to eight were provided. A greatly extended zone of maximum temperature was achieved in this way, and the bottoms of the loads were held at top heat for a longer period of time (see Fig. 3). This made it possible to fire larger bodies of ware with a satisfactory penetration of

heat. The products of combustion, however, still followed the same path to the entrance of the kiln, and the spaced fireboxes, furthermore, tended to produce a short zone of peak temperature corresponding to each firebox, especially on the sides of the loads.

The next step was to substitute for the comparatively small number of large fireboxes a much larger number of small burners, subdividing the fuel into a great many small jets and extending the application of the fuel over a greater length of the kiln, thereby producing a practically continuous application of heat. The oscillations of temperature opposite the fireboxes were thus eliminated, and a little more control in the preheating zone was possible by utilizing small burners in advance of where their use would have been practical by the older methods.

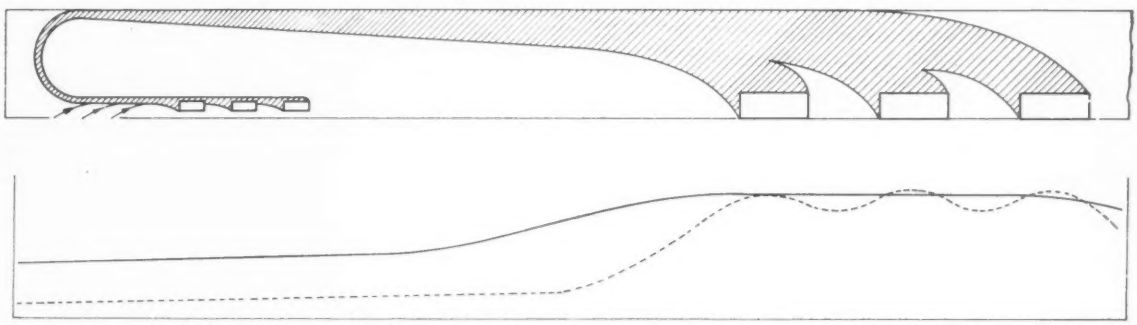
The result, a longer zone of soaking and a somewhat better approach for the bottoms, is shown in Fig. 4, but the problem in the preheating zone remained. This was the stage reached in the late 1920's.



A

TEMPERATURE CURVE TOP OF LOAD
TEMPERATURE CURVE BOTTOM OF LOAD

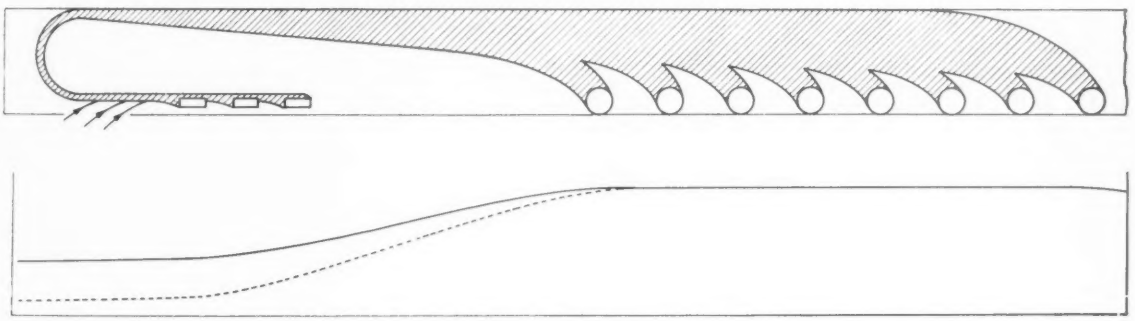
FIG. 2.



B

TEMPERATURE CURVE TOP OF LOAD
TEMPERATURE CURVE BOTTOM OF LOAD

FIG. 3.



C

TEMPERATURE CURVE TOP OF LOAD
TEMPERATURE CURVE BOTTOM OF LOAD

FIG. 4.

IV. Thermocouple Study of Heat Distribution

Although, as mentioned before, kiln designers and kiln operators were aware that there was a poor distribution of heat in the preheating zone, no exact information was generally available regarding this problem because of the difficulty of determining the thermal history throughout the loads at intermediate stages between the entrance and the maximum temperature zone. Cones are of no value for this. The only way in which a true history of what is taking place can be obtained is to mount thermocouples on the cars and have them travel through the kiln, taking temperatures as they pass through the different stages. This is a tedious and expensive job, but in 1927, under the direction of R. H Pass,* it was carried out on two kilns, one direct-fired, and the other, a muffle type. The results were presented to the U. S. Potters Association in 1927 by this Committee and published in the Annual Report for that year.

This report (which is available to all) emphasized a condition which had not been fully appreciated. The curves for the direct-fire kiln, taken from this report, are shown in Fig. 5. They indicate the heat distribution in the different stages of fire of a kiln, operated with four fireboxes on each side, used for firing insulators at cone 11. Couple No. 1 (solid line curve) was mounted exposed on the side of the car facing the source of heat. The broken line shows the temperature of No. 2 couple mounted exposed on the top of the car; No. 3 couple was inside the top sagger; and No. 4 couple was inside the bottom center sagger. Readings were taken at intervals of 15 minutes throughout the length of the kiln. The tremendous lag of temperature on the bottom is clearly indicated. At some points it mounts to 600°F. The rapid increase of temperature on the bottom on approaching the firing zone is shown. The problem of evening up the temperature in that zone has been fairly well overcome, although peaks exist opposite each of the fireboxes, indicated by the exposed side couple No. 1.

The Pass report squarely presented the problem to the tunnel-kiln designers. The question was how to bring the curves together. Engineers and plant operators in the course of years had given a good deal of thought to this condition and a number of devices had been used.

V. Control of Heat Distribution

Faugeron, who built kilns in France which are believed to be the first fairly successful controllable direct-fire kilns and are the prototype of most of the direct-fire kiln designs in use today, made use of refractory shapes mounted on the tops of the loads, conforming closely to the crown of the kiln so as to cut off as far as possible that flue through which the gases could travel. He also provided widened spaces at the sides of the loads in the preheating zone with intervening baffles brought in as close to the ware line as possible, with the object of forcing the gases to pass in and out of the ware settings.

Other designers have dropped baffles from the crown down to the average top loading height of the ware.

* Chairman of the Kiln and Fuel Committee of the U. S. Potters Association. Mr. Pass and his associates are entitled to the grateful thanks of the entire United States pottery industry in making generally available this most valuable contribution to practical ceramics.

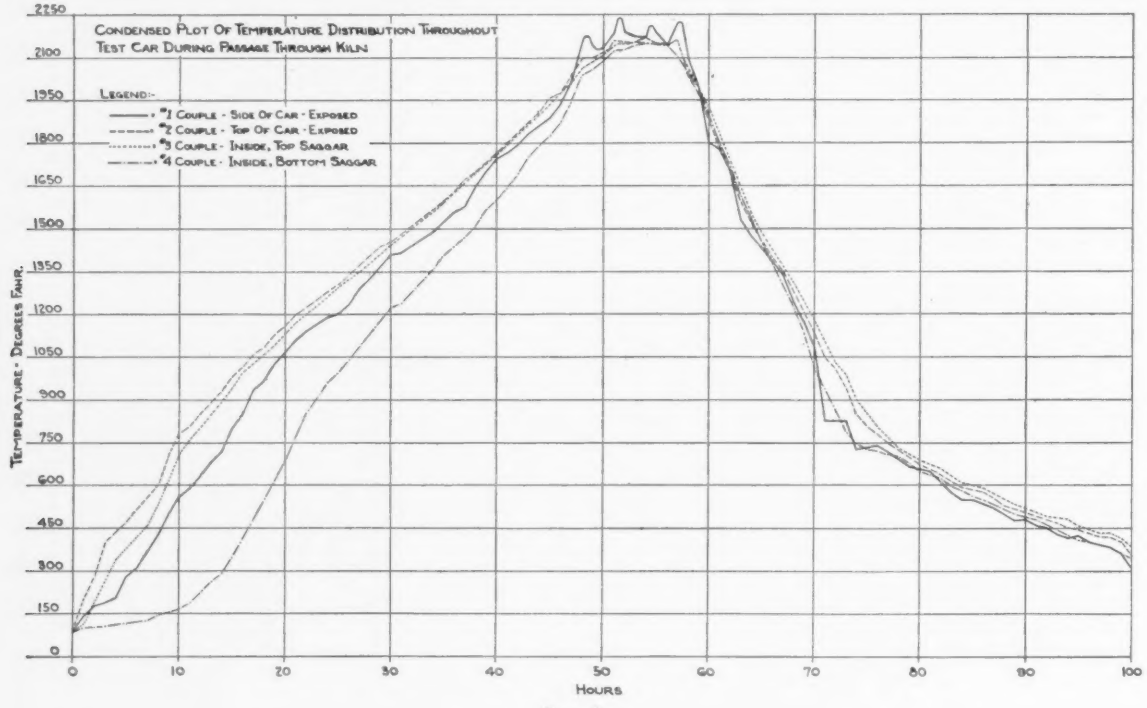


Fig. 5.

The side walls of the kiln in some cases have been sloped to provide wider spaces for the movement of gases at the level of the bottom of the loads. These spaces were made not continuous on both sides of the kiln in some designs but were staggered from side to side.

It has been the practice to restrict the spaces around the ware at the entrance end, closing in on the sides and lowering the crown to narrow up the passages in that zone where gases have shrunk in volume.

All these efforts, however, have been along what might be described as negative lines and have been uniformly unsuccessful in producing more than a palliation of the difficulty because of the necessity of leaving continuous spaces through the kiln for the movement of the cars, thus providing paths of low resistance for the gases to follow. These gases, being in motion, have momentum or kinetic energy, and they follow the straight line of least resistance rather than intricate paths in and out. The curves in Fig. 5 clearly show that the difficulty was not solved by the devices mentioned.

It then became evident that the problem must be approached by positive rather than negative means, that is, by methods of positive fan recirculation.

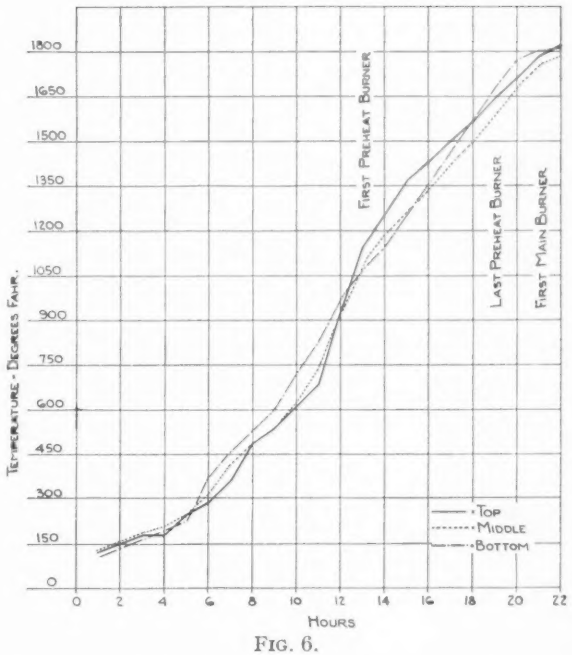


FIG. 6.

(1) Positive Fan Recirculation

Work has been carried on along these lines for four or five years, and a satisfactory solution finally has been reached.

Figure 6 shows a set of curves made by traveling thermocouples in a kiln built in 1937 in a plant producing vitrified dinnerware. These curves represent the thermal history of a load of ware passing from the entrance of the kiln to the beginning of the high fire zone. The solid line represents the curve of the top of the load, the dotted line that of the middle of the load, and the broken line that of the bottom of the load.†

Throughout the preheating zone, the bottoms, instead of lagging behind, are actually ahead of the tops for a considerable portion of the time. The three curves play tag with each other.

† This curve or one similar to it will be published by the Kiln and Fuel Committee in an early issue of the U. S. Potters Association Annual Report.

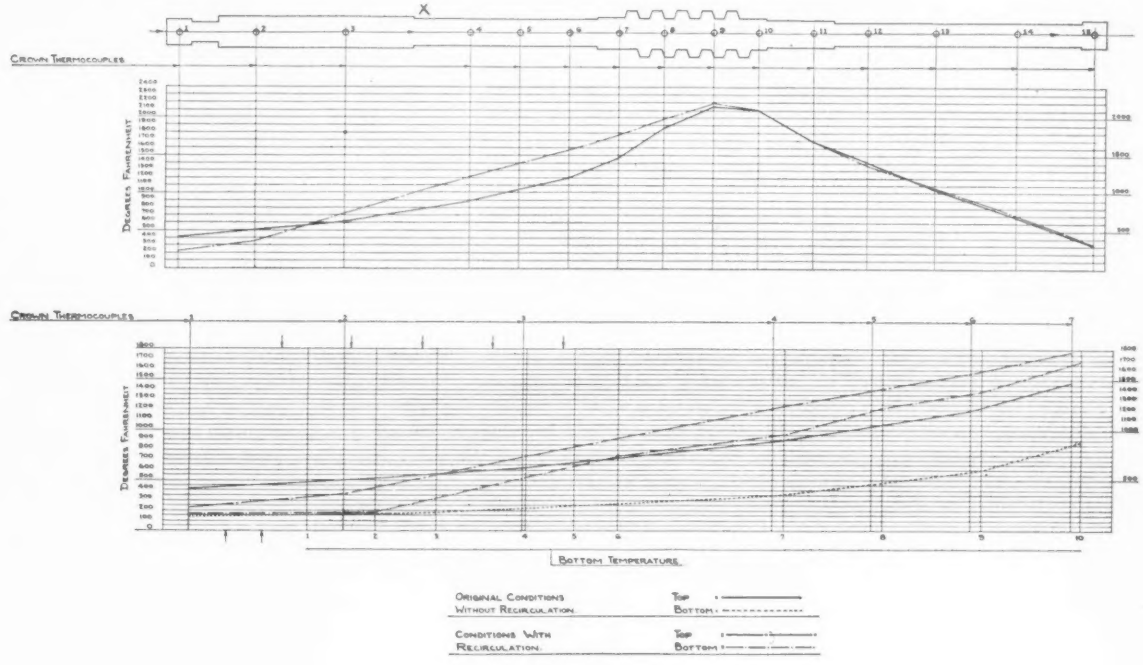


FIG. 7.

These curves, of course, are obtained in a kiln incorporating all the up-to-date improvements in design. The same principles, however, may be applied to the older kilns. Figure 7 shows curves obtained on a firebox-type kiln of the same general design and construction as that studied by the Kiln Committee of the U. S. Potters Association. The crown thermocouples, as originally operated, gave a curve as shown by the solid line, the temperature of the entrance at the top being about 400°F with a short soak at the center of the kiln and a rapid increase of temperature in that zone. The results were not satisfactory because the operator was caught between two difficulties. If the soaking zone were extended, which was desirable from the standpoint of vitrification of the ware, the effect was to raise the top temperature still higher at the entrance and there was a loss from cracked ware, and the ware on the bottoms of the loads meanwhile suffered from lack of oxidation.

To find out exactly what was happening, a study was made of the preheating-zone temperatures of the bottoms of the loads from the entrance up to crown couple No. 7. This is shown in the larger scale graph at the bottom of Fig. 7. The temperatures of the bottoms of the loads were obtained by inserting an exploratory thermocouple through the sides of the kiln at a series of points throughout the preheating zone, this thermocouple being long enough to reach to the center of the load. The dotted line shows the thermal history of the bottoms of the loads. Practically no temperature advance took place for a great distance into the kiln; actually, at a point corresponding to crown couple No. 7 just ahead of the first firebox, there was a lag of nearly 600°F between the bottoms and the tops.

(2) Extension of Auxiliary Burners

The problem was to improve this condition. Positive recirculation methods were installed at the entrance of the kiln throughout the offtake zone. This permitted auxiliary burners to be extended from the fire zone down to the point *X*. The top curve, as a result, was changed as shown on the graph; it was cooler at the entrance than previously but much hotter all through the zone of approach to the main burners, and the bottoms finally were given the curve indicated, being actually hotter through a good part of the length of the kiln than the tops had been previously. The result of these changes has been a 30% increase in the output of the kiln, with more satisfactory firing and lower losses than previously, on the slower schedule.

VI. Long Kilns Unnecessary

Another point was brought out clearly by this change, viz., that the kiln was 40 feet longer than it should have been. With the proper utilization of the heat in the products of combustion by the recirculation method, contrary to the widely held opinion, there is a positive disadvantage in having too long a kiln because this tends to create a zone where condensation can take place.

VII. Conclusions

This discussion has been confined to the preheating and firing zones of direct-fire kilns. Methods, however, have been worked out to secure satisfactory control in the cooling zone, and the same principles may be applied advantageously to the muffle-type kiln.

In conclusion, it may be stated that the age-old problem of securing satisfactory distribution of heat both in the cross section and in the length of the preheating zone of tunnel kilns has at last been mastered and that by using the principles and methods discussed in this paper, the tunnel-kiln designer can reproduce practically any firing curve throughout the entire setting of ware on a kiln car that the ceramic research engineer finds to be most suitable for a particular class of product.

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II. THERMAL HISTORY OF THE GLASSY PHASE AND ITS EFFECT UPON PHYSICAL PROPERTIES*

By Woldemar A. Weyl

Abstract

The properties of ceramic ware, such as refractories, whiteware, enamels, and glazes, must depend on the firing schedule and the rate of cooling. The firing of these products involves systems which react toward a certain equilibrium they do not reach. When the ware is cooled, the reactions are arrested, and the nonequilibrium state which is frozen in determines the properties of the product. The formation of a glass as a bond plays an important role. The formation of this glass and the influence of heat treatment on the properties of glasses are discussed here.

I. Initial Glass Formation

The formation of a glass phase may be followed easily with a fluorescence indicator. This method was developed for studies of the melting behavior of different glass batches,[1] and it has proved to be helpful in

* Received May 19, 1939.

[1] C. Kühl, H. Rudow, and W. Weyl, "Behavior of Oxygen-Releasing Compounds in Glass in the Melting and Fining Process," *Glastech. Ber.*, **16** [2] 37–51 (1938); *Ceram. Abs.*, **17** [6] 214 (1938).

an extensive investigation on steatite masses.[2] The method is based on the fact that uranium oxide or the sodium uranates do not show any fluorescence when they are treated with ultraviolet light which has been filtered free of visible light, whereas glasses containing only traces of uranium become strongly fluorescent.

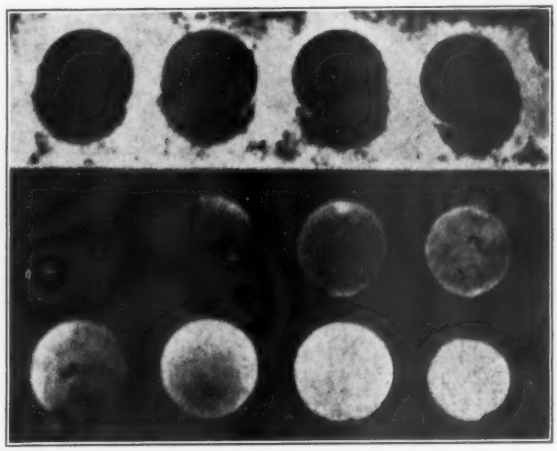

FIG. 1.—Series of steatite bodies fired at 1200°, 1250°, 1300°, and 1350°C, respectively.

Figure 1 shows a series of ceramic bodies made out of steatite (talc) and fired at 1200°C, 1250°C, 1300°C, and 1350°C, respectively. One per cent of uranium oxide was added to the batch. The first series, which represents very pure steatite free from glassforming impurities or additions, did not develop fluorescence. The second series represents a batch made from 82% steatite, 14% kaolin, and 4% calcium carbonate. The development of the glass phase starting above 1200°C may be distinctly followed. According to Andersen,[3] the melting point of the eutectic in the system forsterite ($2MgO \cdot SiO_2$)–anorthite ($CaO \cdot Al_2O_3 \cdot 2SiO_2$)–silica ($SiO_2$) occurs at 1222°C. The third series was made of the eutectic mixture to demonstrate the strong fluorescence of the glassy phase and the fact that this fluorescence disappears entirely when the glass has been devitrified by heating at 1100°C for five days.

II. Effects of Cooling Rate on Properties

The properties of ceramic bodies are greatly influenced by the amount of glassy bond and by the properties of this glass, including their susceptibility to changes during heat treatment. To answer the question of how glasses that have reached a rather high degree of homogeneity are influenced by thermal treatment, it is necessary to show what changes take place when a substance is allowed to cool.

The thermal vibrations of the constituent particles decrease with decreasing temperature, and volume contraction occurs. This process is reversible, and different volumes may be attributed to different temperatures; this may be done so closely in certain cases that such volume changes may be used for thermometric purposes. The smooth volume-temperature curve in the crystalline state may be interrupted when one crystal form changes into another. If the atomic arrangement in the one crystal form is similar to that in the other, e.g., high and low quartz, such a change takes place instantaneously when the equilibrium temperature is reached. Major changes in crystal form require time and may be easily supercooled.

Figure 2 presents a schematic picture of the two types of inversions. The atoms, in the prompt inversion, undergo only slight movement and change in their valence angles, whereas when the atoms have to undergo a complete rearrangement, a sluggish inversion is the rule. Before X rays revealed the structure of crystals, Königsberger[4] concluded that modifications of minerals, which do not differ greatly in their symmetry, show a rapid inversion, whereas a sluggish inversion is observed in cases in which the modifications possess marked different properties, such as wollastonite-pseudowollastonite.

Corresponding types of changes take place when a glass melt is allowed to cool. This may be demonstrated with the well-known example of thermal expansion and contraction.

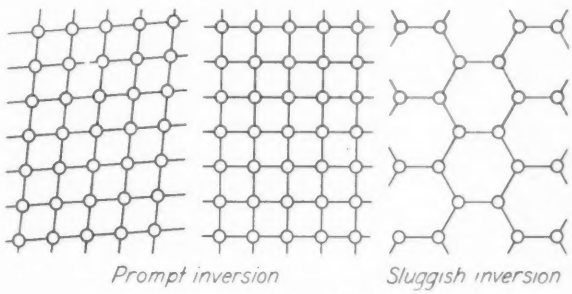

FIG. 2.—Illustration of Königsberger's rule.

Figure 3 shows the changes in length which may be observed during the heating of a glass rod after differing heat treatments. The writer interprets the characteristic features of these curves as follows[5]: The "physical thermal expansion" of a glass causes a volume change, *ABC*, which is nearly linear. At temperature *B*, the mobility reaches values which permit a molecular rearrangement. Chemically speaking, a dissociation of complexes, such as borosilicates, might take place, leading to a volume effect represented by the S-shaped curve, *DE*. The superposition of *ABC* and *DE* leads to the well-known shape of the expansion curve, *ABF*, which is characteristic of a well-

[2] W. Büssem and C. Schusterius, "Constitution of Steatite: I, Crystalline Phase," *Wiss. Veröffent. Siemens-Werken*, **17** [1] 59–77 (1938); *Ceram. Abs.*, **18** [4] 110 (1939).

[3] O. Andersen, "The Ternary System Forsterite–Anorthite–Silica," *Amer. Jour. Sci.*, **13**, 1–44, 133–54 (1927).

[4] J. Königsberger, *Neues Jahrb. Mineral., Geol.*, **32**, 101 (1901).

[5] W. Weyl, "Constitution of Glass: I, Explanation of Glass Anomalies on Basis of Dissociation and Solvation Phenomena," *Glastech. Ber.*, **10** [10] 541–56 (1932); *Ceram. Abs.*, **12** [2] 48 (1933).

annealed glass. The glass is quenched to prevent the inverse process, *ED*, from taking place. Freezing is taking place in a high-temperature equilibrium because the association of the simpler constituents to the more complex ones requires time. The thermal vibrations which cause the "physical thermal contraction" cannot be quenched, and the glass volume therefore shrinks from *F* to *G*. The fact that *FG* is not parallel to *CA* indicates that the chilled glass and the annealed glass have different structures and therefore different physical thermal-expansion rates. Chilled glasses are known to have higher coefficients of thermal expansion than annealed glasses.

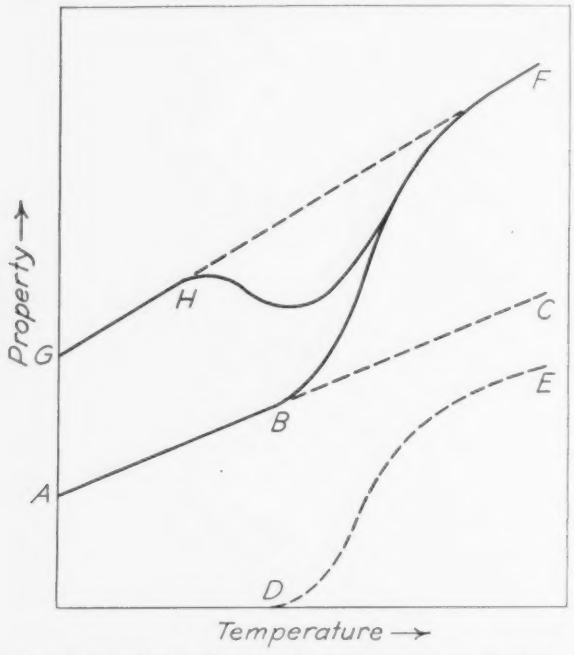

FIG. 3.—Analysis of thermal-expansion curve of glass.

Because of its higher degree of dissociation, the mobility of chilled glass reaches values which permit atomic rearrangements at much lower temperatures than with annealed glasses. When the chilled glass is heated slowly, atomic rearrangements are possible at the low temperatures above *H*, and a volume contraction occurs, caused by the tendency to form more complex molecules, which more than overcomes the continued physical thermal expansion.

Returning to Königsberger's rule, the physical thermal expansion, caused by the increased thermal vibrations of the atoms, is found to take place instantaneously. This reaction is comparable to the type of inversion in which the atoms remain in positions geometrically similar. When the glass offers less resistance with increasing fluidity, another process takes place which involves atomic rearrangements, and it is comparable to the sluggish type of inversion. This inversion requires time and is probably due to a change in the dissociation-association equilibrium of the glass-forming constituents or, using the modern conception, to a change in the average co-ordination number. The fundamental difference between the two processes is that the first cannot be overheated or supercooled, whereas the second may be supercooled easily.

The changes in length or volume are used here only as examples, and similar observations and explanations may be obtained for other physical properties. One of the characteristics of the vitreous state is that the properties are not given if only the chemical composition of the glass and the temperature at which the measurement is made are known. The thermal history of the glass is also necessary. The glass not only "remembers" its previous heat treatment, but it also seems to have a "memory" for previous treatments generally. Elastic aftereffects were among the first of such phenomena to be studied intensively. They are the expression of the fact that the elastic deformation of a glass is affected by previous mechanical forces. Previous electric history is expressed similarly in the electrical properties of glass as Guyer[6] has demonstrated.

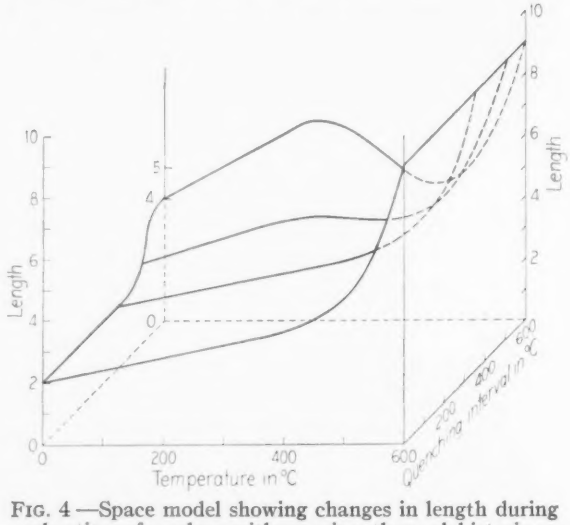

FIG. 4.—Space model showing changes in length during reheating of a glass with varying thermal histories.

A space diagram is necessary to plot the properties of a glass as a function of the temperature. In Fig. 4, an attempt is made to present the length of a glass rod as a function of temperature and, at the same time, of heat treatment. This picture of the behavior of a sodium-borosilicate glass is somewhat idealized. An accurate description of the heat treatment is difficult because factors, such as the absolute size and the shape of the sample, as well as the heat conductivity of the glass and the quenching medium, must be included.

The front side of the space model represents the expansion curve of the annealed glass, and the back side is that of a severely quenched glass. The right side is a straight line, indicating that the properties of this particular glass at 600°C are no longer influenced by its previous heat treatment. The left side indicates how the property, the length in this case, is influenced by the previous heat treatment. Numerous papers deal with the properties of glasses as functions of

[6] E. M. Guyer, "Electrical Behavior of Glass at Room Temperature," *Jour. Amer. Ceram. Soc.*, **16** [12] 607–18 (1933).

thermal history, and the density, refractive index, electrical conductivity, and absorption spectrum are known definitely to be influenced by the heat treatment. In Figs. 5 and 6, the four faces of the space diagram are represented individually.

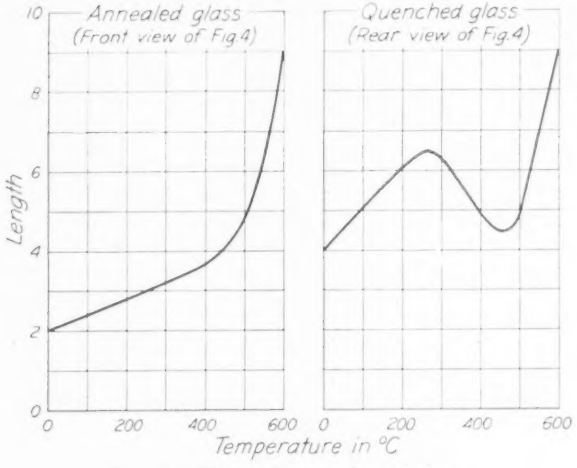

FIG. 5.—Thermal expansion of glass.

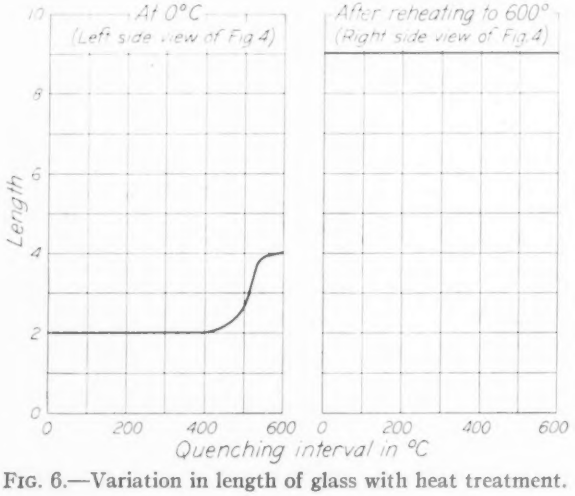

FIG. 6.—Variation in length of glass with heat treatment.

Figure 7 is taken from a paper by Bernard Long[7] to show that in ceramic bodies, even where the glassy phase forms only a minor constituent, the expansion is definitely influenced by the heat treatment. Such measurements could be used to estimate quantitatively the proportion of glass phase present in the body, but the technique is difficult. Dielectric-constant measurements seem to have a greater value for such determinations.

A new method has been developed to measure the dielectric constants of glasses even in the form of a very fine powder.[8] Studies on the change of the dielectric constant with different heat treatments have revealed a strong influence of thermal history. Because the change of the dielectric constant with temperature in crystalline materials is strictly reversible, the differences in the dielectric-constant values between the chilled and the annealed samples are due only to the proportionate effect of the glassy phase.

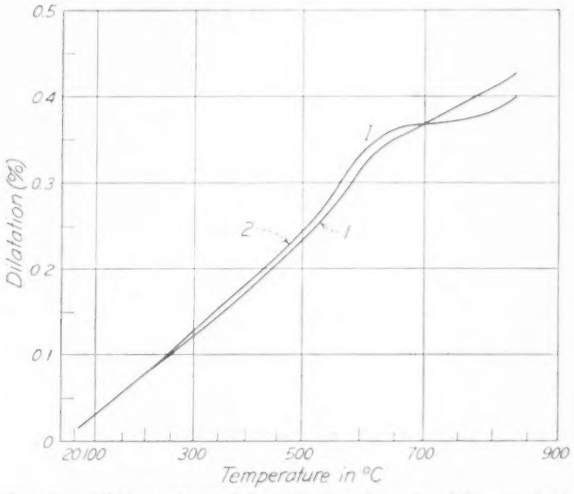

FIG. 7.—(1) Test piece without internal strain; (2) quenched test piece.

III. Conclusion

Further development and application of methods, similar to those described here, should help the ceramic technologist to understand the reactions of his materials more fully and to control the physical properties of his products which are particularly dependent upon heat treatment.

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Discussion

G. A. BOLE: Can you, Dr. Weyl, tell us something about the effect of incidental minerals and their effect on fluorescence?

W. A. WEYL: The fluorescence method, based on the addition of uranium oxide, has two fundamental restrictions, viz., (1) fluorescence cannot be obtained if the glass is formed under reducing conditions and (2) too large amounts of iron oxide in the glassy phase interfere with fluorescence.

Cobalt oxide may be used to advantage as an indicator of the glass formation in some cases because it is not affected by reducing atmosphere and its strong color is visible even in dark-colored glasses. Its use, however, is restricted to those materials which do not form crystals of the type of spinel. Cobalt has the property of being capable of going into the lattice of spinels which is not true of uranium.

[7] Bernard Long, "Vitreous Phase of Certain Ceramic Materials," *Céramique*, **37** [553] 81–86 (1934); *Ceram. Abs.*, **14** [1] 24 (1935).

[8] H. J. Funk, dissertation, Berlin, 1937.

III. EFFECT OF THERMAL HISTORY ON THE PHYSICAL PROPERTIES OF ELECTRICAL PORCELAIN*

By E. H. Fritz and H. C. Harrison

Abstract

A brief review of the firing requirements of electrical porcelain is presented. Some factors are traced in the relation of body composition, thermal history, and coefficient of thermal expansion of the fired body with its resultant effect upon the modulus of rupture of the glazed body.

I. Introduction

Electrical porcelain has several physical requirements which may be affected by the thermal history of the ware, viz., (1) it must be completely impervious; (2) it must have high strength and toughness (which may be considered the same); and (3) it is manufactured by the one-fire process in rather complicated shapes that involve abrupt changes in cross section and in ware weighing hundreds of pounds per piece.

The use of the car tunnel kiln to fire electrical porcelain has produced more exact control of the firing and improved uniformity of properties in the ware.[1]

The time-temperature-atmosphere conditions for the most rapid oxidation of heavy sectioned ware have been determined.[2] This development has been particularly useful in manufacturing electrical porcelain because of the rather high ball-clay content used in some body compositions. The necessity of finer and more uniform grain size in the nonplastics has been reported in the development of better vitrification. The change in the value of the coefficient of thermal expansion of quartz and its abrupt volume change at 575°C, moreover, have been considered in the development of more rapid cooling rates and in the improvement of the quality of the ware.[3]

II. Effect of Rapid Cooling

These developments are of general interest to the ceramic industry and have had an application somewhat parallel in all of its branches. The requirements of electrical porcelain of zero permeability and high strength as well as the economies of short firing cycles have produced results which may be more closely related with this one branch.

Porcelain test bars, 3/4 inch in diameter and 6 inches long, that have been cooled rapidly from their vitrification temperature have developed a modulus of rupture of 15,800 lb. per sq. in. This strength, compared with a value of 11,500 lb. per sq. in. for bars of the same size and cooled in the usual manner, shows an increase of more than 35% in strength. This increase seems to be due to a favorable strain pattern at the surface of the bars caused by the rapid cooling. It is comparable with the pattern obtained in tempering flat glass. These results unfortunately have not been applied in commercial shapes, owing to the complications introduced by surface contours and differences in cross section.[1] Similar results, however, may be obtained by the proper selection of glazes, which have been reported by Riddle and Laird.[4] The surface of the ware may be held in a desirable state of compression at ordinary temperatures by the selection of glazes with thermal expansion lower than that of the body.

III. Effect on Expansion Coefficient of Body

Considering the commercial range of body compositions and tunnel-kiln schedules, the coefficient of thermal expansion of the glazes seems to be much more stable than that of the electrical porcelain body. This appears logical because the glaze at maturity approaches equilibrium much more closely than the body. The glaze, therefore, will be considered to be stable, and the effect of thermal history of the ware on glaze fit will be discussed, that is, the changes in the coefficient of thermal expansion of the porcelain body relative to that of the glaze with consequent variations in the strength of the glazed ware.

Glazed test bars appear to be more susceptible to modifications in thermal history than unglazed bars. The effect of alterations of the firing schedule and of repeated reheating on the strength of unglazed test bars seems to be a minor factor if it is compared to the fluctuation in strength of glazed test bars occasioned by changes in the coefficient of thermal expansion of the porcelain body. Changes in this coefficient in the range of 5×10^{-6} to 6×10^{-6} have been observed in some electrical-porcelain body compositions when extreme variations in the firing schedule have occurred. A determining factor appears to be the rate of heating as the vitrification period is approached. Shelton and Meyer[5] studied the effect of temperature rise on the reactivity of the glass phase at this period. Within limits, the low values are obtained with the more rapid rates of temperature rise and the higher values with the lower rates.

* Received April 17, 1939.

[1] E. H. Fritz, "Present Practice and Developments in Firing Electrical Porcelain," *Jour. Amer. Ceram. Soc.*, **20** [1] 26–30 (1937).

[2] H. M. Kraner and E. H. Fritz, "Rate of Oxidation of Porcelain and Ball Clays," *ibid.*, **12** [1] 1–13 (1929).

[3] H. Kohl, "Thermal Expansion and Some Other Physical Properties of Fine Porcelain as Affected by Composition and Firing Temperature," *Ber. deut. keram. Ges.*, **3** [6] 303–44 (1922); *Ceram. Abs.*, **5** [2] 60 (1926).

[4] F. H. Riddle and J. S. Laird, "Control of Glaze-Fit by Means of Tensile Test Specimens," *Jour. Amer. Ceram. Soc.*, **5** [8] 500–503 (1922).

[5] G. R. Shelton and W. W. Meyer, "Nature of Glass Phase in Heated Clay Materials: II, Effect of Rate of Heating on Glass Phase and Physical Properties of Whiteware Bodies," *ibid.*, **21** [11] 371–85 (1938).

A variation in coefficient of thermal expansion of the porcelain body with a given glaze may alter the modulus of rupture of the glazed test bars by more than 5000 lb. per sq. in. Body composition and thermal history must be maintained within certain interrelated ranges to secure ware of high strength and a good glaze fit. A summary of test observations seems to indicate that the coefficient of thermal expansion of the porcelain body may be closely related to small changes in the composition of the glass phase.

IV. Effect of Body Composition

Because possible changes in the coefficient of thermal expansion of the porcelain affect the strength of the ware so much, the effects of the various body components on the susceptibility to these changes are summarized.

(1) Ball Clay

Test results indicate that the ball clays have the least important effect of any of the body materials on the susceptibility of the body to changes in its thermal history.

(2) Flint

The flint content of a porcelain body appears to have a double role in its effect on the thermal expansion. As quartz, it raises the value, but as the flint is taken into the glass phase it lowers the value.

Inasmuch as quartz has the highest thermal expansion of the fired porcelain ingredients, the percentage of flint in the body is a deciding factor in the magnitude of the thermal expansion of the fired ware. The grain size of the flint used is a factor in determining the rate of change of the thermal expansion of the porcelain with variations in the firing conditions. The greater the surface area of the flint for a given maximum grain size, the greater is the rate of change. This property of the flint, viz., that of changing from a body ingredient with the highest factor in the thermal expansion when it is present as quartz to the lowest as it enters the glass phase, may lead to stricter specifications for its purchase when close control of body characteristics is necessary. A maximum surface area may be specified to accompany a given maximum grain size, or the trend may be to a body ingredient other than quartz.

(3) China Clay

The china-clay content of the porcelain batch shows varied effects on the thermal expansion of the body, depending on the source of this clay. Present observations indicate that, with other conditions being equal, Georgia kaolin gives a thermal expansion value lower than that obtained from North Carolina kaolin.

(4) Feldspar

The most important factor in determining the susceptibility of an electrical porcelain batch to changes in physical properties which result from variations in the thermal history of the ware seems to be the chemical analysis of the feldspathic flux used. The character of the flux accentuates the minor trends which have been listed. A feldspar, relatively high in potash, is needed to produce large heavy pieces of ware. The same characteristics seem to persist in determining the rate of change of the coefficient of thermal expansion with changes in the thermal history of the ware.

An increase of potash and a consequent decrease in soda in the feldspathic flux, with certain limits, will lead to lower rates of change of thermal expansion under varied firing conditions. This trend practically stops when the ratio of the two alkalis in the flux is of the order of about 1 molecule of soda to $2^1/_2$ molecules of potash, but it increases rapidly as the ratio of soda to potash increases above this value. The thermal expansion of the body seems to change more rapidly than other properties with altered conditions.

V. Effect of Glaze Fit

The physical properties of electrical porcelain, as with all ceramic ware, are decidedly affected by glaze fit. The range of compositions of bodies and glazes used in this ware is such that changes in the heating rates as the vitrification period is approached affect glaze fit more through variations in the thermal expansion of the body than through direct changes in the properties of the glaze.

VI. Conclusions

The various body materials affect the rate of change of thermal expansion of the body to different degrees with modifications in firing. The clays, especially ball clay, seem to be assimilated so rapidly into the glass phase that they have little effect on the rate of change. The grain size of the flint has some effect on the rate of change as the surface area of the flint is altered. The dominant factor causing variation of the thermal expansion of electrical porcelain seems to be the chemical analysis of the feldspathic flux used.

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EFFECT OF FIRING SCHEDULE ON QUALITY OF GLASS COLOR DECORATIONS*

By Campbell Robertson and Daniel O. Koch

Abstract

A systematic investigation has been undertaken of the effect of the firing schedule on the quality of vitrifiable glass color decorations applied by the screen process. An experimental gas-fired decorating lehr with a 30-foot tunnel was used. The ware was fired at a wide variety of schedules, recorded automatically from thermocouple junctions in contact with the ware, and the schedules were correlated with observations of the finished quality. A definite and fairly sharp critical temperature was indicated for the best elimination of medium, and time at or near this temperature is much more effective than equivalent times at higher or lower temperatures. An "ideal" firing schedule has been tentatively established to serve as a working basis for the improvement of full-scale lehr operation.

I. Introduction

The firing of vitrifiable decorations on glassware has become a major operation in the glass industry, and yet comparatively little is known of the fundamental physical processes underlying the firing operation or of the exact correlation of lehr-firing schedules with the quality and uniformity of the resultant decoration. In consequence, present-day firing practice is subject to wide variations in loading and belt speeds with resultant failure to obtain the maximum production of first-quality output from any given lehr and type of ware.

The importance of the problem of firing has been accentuated by the latter-day trend toward the use of highly acid- and alkali-resistant colors. These colors, by reason of the chemical and physical properties needed to obtain the maximum resistance to chemical agents, in general possess somewhat less flexibility than do colors of the old nonresisting type. A wider understanding of optimum firing conditions is therefore doubly important to maintain the best possible production rate and the best chemical-resistant qualities in the ware produced.

The program of firing studies, of which this paper represents the beginning, has been planned to build up a useful backlog of experimental determinations of firing behavior in such a form that the information obtained may be applied readily to plant operating conditions. An undertaking of this nature and extent was made possible only through the recent availability of a 30-foot experimental lehr, in which for the first time actual lehr-firing curves may be obtained under the numerous sets of controlled conditions needed to establish experimental conclusions on a sound basis. To keep the work within practical bounds, this initial phase has been restricted experimentally to alkali-resisting colors applied by the screen process. The factors other than firing which also affect quality, such as nature of color, type of medium, thickness of application, etc., have been selected to represent the average of present commercial practice.

The object of this immediate program therefore is to establish as far as possible the optimum type of firing schedule for the alkali-resisting colors and squeegee mediums now in use and at the same time to formulate and review the apparent physical and chemical principles which underlie the firing process. The specific time-temperature data thus may be of some direct value, and the discussion of firing principles may serve as a start for the growth of a sound set of concepts in this important field, not merely for alkali-resisting colors but for all glass-color firing.

II. Equipment and Experimental Methods

(1) Lehr

A specially designed and constructed experimental decorating lehr was available for this work and was used to obtain substantially all of the experimental data. This lehr was of direct-fired design with a tunnel 30 feet long, a belt 1 foot wide, and a 1-foot roof clearance. Propane was used as fuel, and the relative lengths of preheat, firing, annealing, and cooling zones, as well as the relative positions of the thermocouples, were scaled to the corresponding dimensions on production-size lehrs. The main top and bottom burners each had independent automatic controllers, and ten thermocouples were connected to an indicating pyrometer through a multiple-point switch.

The lehr is operated most of the time with an empty belt, that is, with no loading other than experimental pieces, which ordinarily means an average of not more than a few ounces per square foot. Originally projected as an economy feature, the empty-belt method of experimental operation has proved to be satisfactory in all respects and to have some decided points of advantage over full-belt operation in obtaining experimental data. It has been demonstrated through several sets of runs of 48 to 60 hours' duration that similar pieces show comparable firing behavior either on the empty belt or on a belt kept loaded to 9 lb. per sq. ft. In changing from empty belt to full belt or the reverse, it is necessary, of course, to readjust all the burners and draft settings in order to establish the same temperature gradients, but once these are established, there are no observable differences between the two types of operation.

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(2) Recorder

A three-point, strip-chart, automatic recording instrument was set up at the entrance end of the lehr, and a supply of traveling thermocouples was made up from 20-gauge Chromel and Alumel wire insulated with 3-inch double-hole porcelain tubes separated by beads. The instrument speed was set at 4 inches per hour so that the charts obtained are directly of usable scale and dimensions to eliminate the need of any plotting. All of the trials were based on traveling-couple curves, although the complete set of lehr-couple readings was maintained at all times for comparison. The traveling couples had bare ends and were either in contact with the decorated area on the ware at approximately its center or not more than a fraction of an inch out of contact with this area.

(3) Ware

The major portion of the work was done on heavy-walled, 12-ounce beverage bottles with plain panels of color, about 2 by 2 inches, applied by the screen process. Usually the two colors applied were partly overlapped, so that each bottle showed an area of each color as a single layer and a superimposed area. The colors and mediums used were representative of those in established use in this field.

(4) Method of Operation

The practice at the outset was to fasten a traveling couple to the belt so that the tip was in the correct position next to the sample and to fire the sample through at belt speed and temperature settings aimed to give the traveling-couple curve desired. This method was found to be extremely time-consuming, owing to the length of time needed to bring the lehr to equilibrium at a new set of conditions for each experiment plus the fact that it was uncertain that the set of conditions established on the basis of the lehr thermocouples would yield the exact traveling-couple curve desired.

An entirely new technique therefore was devised which overcame these objections. The principle of this procedure is to establish the lehr in equilibrium at a very rapid belt speed (up to 35 minutes through time) and to place the pieces to be fired on a skid support which may be attached to a chain or wire held manually at the lehr entrance. By this means it is possible to subject a piece of ware to virtually any firing curve desired by having the operator watch the recording instrument beside him and to hold or release the piece at different positions.

Practically perfect flats on the curve are obtained by holding the piece still and allowing the belt to "skid under it," and curves of any slope desired, within the limits determined by the attainable belt speed, can be "made-to-measure" by alternately holding and releasing the piece for fixed numbers of seconds. The method is completely flexible, so that even retrograde curves may be obtained, and it is also possible to pull the piece out for examination at any point in the firing cycle. The use of the method of course requires the empty belt, and the possibility of using this experimental technique is one of the great advantages of empty-belt operation.

The simple device employed during most of the work for firing single 12-ounce bottles consists of a flat piece of 18-gauge iron, $2^1/_2$ by 6 inches. The bottle stands on one end, held by four small ears cut out and turned up, and the other end is narrowed down and formed into a hook to which the traveling-couple is fastened about 5 inches from its tip. The couple itself in this case is used simultaneously as the indicating means and as the holding means, eliminating the need for the complication of a separate chain or wire.

III. Objectives of Experimental Program

The organization of the experimental program is based on two clearly stated objectives: (1) to produce fired decorations of the highest technical quality and (2) to obtain this result at the shortest possible time through the lehr.

(1) Quality

The judgment of technical excellence of a fired decoration or label is based upon observation of the following properties:

(*a*) *Color Quality:* Clarity and brilliance must be good, with no evidence of darkening or fading.
(*b*) *Surface Texture:* Surface should approach as closely as possible a true smooth glassy finish, and irregularities of texture if present should be uniformly distributed.
(*c*) *Abrasion Resistance:* Fired layer should resist vigorous abrading with a knife blade, and there should be no "skin finish," e.g., a smooth glossy surface underlaid by a spongy or porous texture of the color layer.
(*d*) *Alkali Resistance:* Should be equal to standard; this proviso must be considered because of some evidence that extreme variations in firing conditions are apt to affect the resistance.
(*e*) *Ware Strength:* Color must not impair the strength of the ware as to thermal shock, mechanical shock, or pressure.

It is unfortunate but true that in the present state of the art none of the foregoing qualities is capable of being completely specified quantitatively. Judgments, for the most part, therefore, must be comparisons of each experimental piece with standard pieces representing current production practice; these standards, however, are essentially reference points rather than ultimate goals of performance.

(2) Firing Time

It is accepted as axiomatic that the through-time should be reduced as much as possible, inasmuch as by this means major production increases may be brought about. The limit in this direction probably will be set ultimately by the characteristics of the ware rather than by those of the decoration. For the purposes of this program, no absolute top limit has been set to the broad objective of high firing speed, and in many cases it may have exceeded the limitations of commercial ware. A knowledge, however, of the maximum thermal or firing stresses which the color will withstand will be of value even though it is not directly applicable in full to glassware as it is now handled. In such a

case, it will at least focus the problem and thereby pave the way for further progress.

IV. General Discussion of Firing Process

To provide an adequate basis for review of the experimental data and because no comprehensive picture of the firing process for glass colors has heretofore been presented, the various factors which affect the final technical quality of a fired decoration on glass are listed and discussed. A tentative concept is also offered of the firing process which served in part as a basis for planning this experimental work. The writers feel that this picture of the firing process is little more than a preliminary hypothesis, and it is hoped that sufficient additional data may become available to provide a foundation for broader conclusions.

(1) Composition of Unfired Color Layer

The layer of applied color, before firing, consists of at least four separate phases, viz., (*a*) flux particles of size ranges from about 2 to 30 microns, varying somewhat with different shades and types of color; (*b*) an opacifier (if opaque flux is not used) which may be lead molybdate, tin oxide, or zirconium oxide; the opacifier particles in any case are usually of the order of 1 micron and in some cases much finer; certain colors, of course, do not require the use of opacifiers; (*c*) a pigment which may consist of one type or more than one type of colored particles; and (*d*) a binder from the squeegee medium, probably always containing an unevaporated remainder of the solvent.

(2) Factors Affecting Final Properties of Fired Color

The principal factors of variability in firing of vitrifiable colors are as follows: (*a*) *The Color:* Some variability is encountered in the readiness or difficulty of firing the colors, especially in the breadth of the range of conditions under which they fire satisfactorily. Some colors require a more exact set of conditions than others. These variations in colors are related in considerable degree to the composition variations required to furnish the shades and degrees of resistance needed.

Because the color composition must be governed to a great extent by other considerations, it is not feasible to formulate a flux entirely on the basis of firing behavior; these studies therefore have been based on the use of alkali-resisting colors known to be in proved successful use, and this presumptive factor of variability has been maintained constant by this means.

(*b*) *Medium:* The medium is of great importance in the firing process, quite aside from its paramount importance as a mechanical aid to get the ceramic color onto the ware. The importance of medium in firing resides chiefly in the nature and quantity of the binder and other unevaporated material left in the color layer as the ware enters the lehr. This material must ordinarily be removed under the heat, and the largest part of a successful firing process is bound up with the proper and effective removal of medium. Mediums are subject to great variation, and with some now available, the firing flexibility is greatly increased.

(*c*) *Thickness of Color Layer and Fineness:* These factors are of considerable importance. The difficulty of removing the medium is affected in large degree by the total depth of color and by its fineness. Superimposing of course doubles the effective thickness, and the type of screen used also has a great effect on this factor.

(*d*) *Lehr Atmosphere:* The atmosphere plays a part in the proper and complete removal of the residue from the medium. After the medium is once burned out completely, the atmosphere is of small importance unless it becomes so highly reducing as actually to interact with the color itself; this extreme condition, however, is seldom encountered. This variable is impossible to reproduce or to control with accuracy under any but actual production conditions, so that there has been no attempt to make variations of this factor.

(*e*) *Time-Temperature Curve:* The firing curve is approximately on a plane of equal importance with the other factors in determining the final quality of fired color. Any major change in color, medium, or lehr atmosphere may force an alteration of the firing curve. Likewise, if a certain desired firing curve is used at the start, it may be necessary to alter one of the other factors to make it operable.

The practical problem usually involves a compromise among the adjustments permissible in the various factors, but the lehr firing curve should be the factor of greatest flexibility. There are two angles to be considered in a lehr schedule, viz., (1) the total through-time, which determines total production, limited of course to some degree by the loading weight permissible and by the annealing requirements, and (2) the exact shape of the time-temperature curve, which may be subject to extremely wide variation within a constant through-time interval. It is with this question of curve-shape that we are mainly concerned in this present work.

(3) Concept of Firing Process

The stages in firing a glass color are (*a*) volatilization of residual solvent left from medium; (*b*) volatilization and cracking of solid organic binder, usually decomposing them into carbonaceous or tarry residues and gases which escape; (*c*) burning of carbonaceous residue; (*d*) incipient fusion of flux particles; (*e*) flowing together of melting flux particles to give a continuous sealed glassy structure through which some trapped gases still are escaping as bubbles, leaving behind pits and craters; and (*f*) final "healing" or flowing of fully melted color into a uniform film and leveling of surface irregularities.

The degree of success and the possible speed which may be attained in a firing operation depend in large degree on whether stage (*c*) is complete before stage (*d*) begins. The carbonaceous residue, in other words, must be completely or nearly completely burned away before the flux has softened enough to seal any

appreciable quantity of the carbon against free access of air.

Failure to realize this condition means either that carbon is left behind in the finished color, darkening it, or, more commonly, the carbon is finally burned out, perhaps in part through the action of oxygen dissolved in the molten flux, giving rise to bubbles in the color layer. These bubbles may stay imbedded, giving a "soft" or easily scratchable surface or a "skin finish" in which there is a superficial surface glass over a cellular understructure; if the bubbles escape, they may create surface defects of such extent as to be not healable during the remainder of the firing, giving a final roughness or even visible blistering. This roughness in some cases may be interpreted as simple hardness of the flux, as it may assume a variety of deceptive appearances.

Carbonaceous residues do not always give any pronounced darkening even though present in appreciable quantity. This is a point on which it is easy to be misled, as extremely careful examination is sometimes necessary to detect carbon or carbonaceous material.

Another property of the color which may be considerably affected by the firing is the degree of chemical resistance. This is true in general both for alkali resistance and acid resistance, and the degree of alteration in resistance due to firing in some cases is astonishing. Furthermore, the preheat and hot-zone temperatures not only are important in this property, but the annealing end can also be of prime importance. This subject will be treated more fully in a subsequent publication.

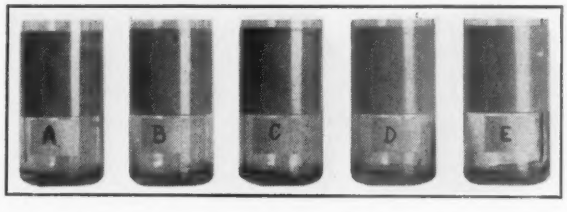


FIG. 1.—Set of grading standards for surface texture.

(4) Experimental Data

The following tables summarize the experimental data, grouped according to types of variation in firing treatment and sample preparation.

(*a*) *Grading of Samples:* An arbitrary scale for sample grading was established by selecting a set of five bottles with color panels about $2^1/_2$ by $2^1/_2$ inches in size and of varying degrees of perfection of surface texture. All the experimental samples were compared with the surface textures exhibited in this standard set. The standard comparison set was selected and rated by the collective judgment of three individuals directly familiar with practical operative standards of acceptance and rejection as currently established. The five samples are designated A, B, C, D, and E, and the letters carry the usual accepted significance as grades, namely that A, B, and C are passable but descending in order of quality, D is a border-line grade which might be passed or rejected by different inspectors, and E is definitely unacceptable. In order to show a rough distinction between different textures, all in the unacceptable range, the E grading has been used for results not far below passable, and multiple E's show roughly the order of poorer results.

It is regrettable that this scale cannot be expressed in some form of absolute unit, particularly because standards are continually undergoing revision. This is not possible at present, however, owing to the complex nature of glass and surface texture factors.

TABLE I

EFFECT OF PREHEAT TEMPERATURES AND TIMES

Initial heating rate, 80°F/min.; top heat, 1070°–1100°F (8 min.)

	Preheat Temp. (°F)	Preheat Time (min.)	Rate to top (°F/min.)	Grading
	None			EE
Rapid rate to top	500	15	70	E+
	600	9	61	E+
	700	8	65	C
	700	30	53	B+
	710	17	39	C+
	780	6	60	C
	880	6	50	EE
Slow rate to top	650	12	28	D
	670	13	31	C
	700	8	18	B−
	700	15	19	B
	700	30	20	B+
	770	15	18	C−
	800	19	23	C
	810	9	23	C
	940	15	20	E

Table I shows the effect of preheat time at different temperatures on the finished product. All these samples were made similarly, with a standard beverage alkali-resisting white applied first and partly superimposed with a red. Both colors were applied with metal screens because the greater thickness resulting would make the most severe test condition, and conditions satisfactory with metal screens undoubtedly would be applicable to silk-screen work. Medium A was used; this medium also was selected as one of the less favorable in relation to its ability to withstand adverse firing conditions.

The firing curves, obtained as outlined previously, were nearly all set up on a four-part basis, made up of linear or nearly linear segments. These parts were (*a*) preliminary heating up, (*b*) holding at preheat temperature, (*c*) heating from preheat to top, and (*d*) holding at top. For the largest part of this work, the portion of the curve through annealing and cooling was not recorded.

Actual lehr curves cannot be made up of strictly linear segments involving sharp changes of rate, but the linear method is subject to more positive and informative interpretation, and in practice actual operating curves may be brought to the closest approximation to the linear type.

Table I shows the variation of preheat temperature and time and the heating rate followed from preheat

to top. The top heat and the initial heating rate were maintained constant for this series of tests.

An examination of the data clearly indicates that at about 650° to 700°F there is an optimum preheat temperature at which the best results are obtained. The classification of results under "rapid rate" and "slow rate" shows that this temperature is approximately the same, irrespective of whether the second heating-up action of the curve from preheat to top temperature is relatively rapid or slow. At the slow rate, however, there is an over-all average improvement, which may well be ascribed to the greater opportunity given for final burning out of the medium, when other conditions are equal.

TABLE II

EFFECT OF VARIATION OF SQUEEGEE MEDIUM AND TIME HELD AT PREHEAT

Initial rate, 30°/min.; rate of preheat to top, 25°/min.; preheat temp., 680°F; top heat, 1100°F, 12 min.

	Medium									
	(A)		(B)		(C)		(D)		(E)	
No.	Time	Grade	Time	Grade	Time	Grade	Time	Grade	Time	Grade
1	4	C−	4	C	5	B+	6	B−	4	B−
2	9	C−	9	C	8	B+	9	B	8	B−
3	13	C	11	C+	12	A	12	A−	13	B
4	17	C+	15	B+	18	A	15	B+	16	A−
5	21	B	19	C+	21	A	20	B+	21	A

The firing data and grading on a set of trials using five different media are given in Table II, in each case following out approximately the same set of five different lengths of preheat at 680°F. Other conditions that are held constant for the series include a fairly slow initial rate of heating up, approximately 30° per minute for 12 minutes, a heating rate to the top of about 25° per minute, and a uniform top heat of 1100°F for 12 minutes.

Because all the conditions in this set of trials are reasonably close to the optimum, all the samples receive at least passing gradings. It is interesting to observe the trend of variation of grading with the length of time allowed at the preheat temperature. About 10 to 15 minutes is about right in each case apparently to get the best results from each medium, although the over-all average level of quality is quite different for each medium.

This series of results indicates rather clearly the considerable importance of choice of medium in obtaining the best absolute quality of result. There may be even greater room for improvement in the development of mediums having the best possible firing behavior. It does not seem impossible that a medium may be found eventually which will be ideal in the sense that it will be completely unaffected by firing rates, thickness, type of color, or other variables. This possibility of finding a medium of ideal firing characteristics is limited of course by the numerous other specifications required of it, such as flow and drying characteristics, dry hardness, effect on screens, and other specifications.

It was impossible within the scope of the present work to attempt an extended investigation of the medium question. The five mediums used were selected as typical of those now in use and originated from five different suppliers. The main purpose in this study was to indicate how best results may be obtained from any medium selected.

TABLE III

COMPARISON OF SILK SCREEN AND METAL SCREEN FOR TWO MEDIUMS

Preheat, 10 min. at temp. shown; top, 1100°, 10 min.

		Grading			
		Medium A		Medium B	
Mean rate of rise	Preheat temp. (°F)	Silk	Metal	Silk	Metal
55°/min.	500	D	E+	C	C
	600	C+	B−		
	700	B	C	B	B
	800	D	D+		
	900	E	E	D+	D
30°/min.	500	D	D	C	B−
	600	C−	B−		
	700	B+	B+	B+	B+
	800	C	D−		
	900	D−	E	C	C+

The comparative behavior of colors on silk- and metal-screen applications was determined, using two different media and covering a relatively wide range of preheat temperatures. The series presented in Table III represents results on superimposed colors under the conditions in each column.

The silk screen and metal screen, in general, do not show any striking over-all differences, although there is a considerable thickness difference. This was surprising, as it had been expected that the greater thickness would perhaps exaggerate the difficulty of burning out the medium. There may undoubtedly be differences observed between the two types of screens in such cases, other things being constant, but this effect is minor compared to some other factors.

V. Summary

The experimental results presented point to several tentative conclusions in regard to the effect of firing on the quality of results.

(1) There is a clear optimum preheat temperature in the vicinity of 675°F, at which the medium is most effectively removed in the shortest time. This temperature does not seem to be a direct function of the nature of the medium, but it holds generally within the field covered.

(2) Different mediums show relatively great variation in firing behavior, other conditions being equal, and there seems to be considerable room for control of results by this means. The effect of medium as a factor in firing is on a plane at least of equal importance with the firing cycle itself.

(3) Thickness of color application is also a factor in determining the quality of results, but it is of a lesser order of importance than the other factors, except under very rapid firing speeds.

E. I. DU PONT DE NEMOURS AND COMPANY
R. AND H. CHEMICALS DEPARTMENT
PERTH AMBOY, NEW JERSEY

A RECIRCULATING RADIATED WASTE-HEAT DRIER OPERATED UNDER CONTROLLED HUMIDITY AND TEMPERATURE*

By H. R. Straight

Abstract

A recently developed method is described in which temperature and humidity are built up in the receiving end with airplane-type propellers. The air in the receiving end continually recirculates over reheating surfaces and gives an updraft over the reheating surfaces and a downdraft through the greenware in which the temperature is being built up under high humidity. Another method of circulation may be used with like propellers differently arranged in the drier section. Combined longitudinal and vertical recirculating is maintained to give a general effect in movement of reheating the air past the radiating surfaces and a general downward movement through the ware being dried. The drier described is adapted to cars or pallets on which hollow ware, brick, or heavy units are dried.

I. Introduction

A new method of drying ware was tried out in 1928 in which the corrosive action of the gases which occur in the chamber where the drier cars are placed might be avoided.

II. Design of Drier

A drier was designed in which banks of radiating tubes were connected at the intake end to a distributing tunnel along the kilns. A receiving header across the discharge end collected together the kiln waste gases and the cooling air of the kilns from the banks of radiating tubes with the moisture-laden air from the drier.

Although round downdraft kilns have a lower fuel efficiency, they were selected to fire the flashed and vapor-colored brick.

The banks of radiating tubes are located between each group of four drier-car tracks. The circulation among the tubes is upward so that the natural buoyancy of the heated air will speed up the recirculation through the ware and past the banks of tubes.

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 29, 1938 (Structural Clay Products Division). Received May 18, 1938. Approved kiln drawings received June 7, 1939.

(1) Circulating Fans Installed

Because natural recirculation is insufficient to heat up and dry three-deck drier cars in the time they are allowed to remain in the drier, a system of twenty-two circulating fans (30-inch, 3-blade, airplane-type) was installed to accelerate circulation.

Before any drying takes place, the whole mass of each brick should be warmed thoroughly, thereby eliminating as much surface drying or "caseharden-ing" as possible. High humidity is necessary in the receiving end of the drier to accomplish such preheating.

Two cars are entered on each track and two cars per track are removed at the discharge end almost simultaneously to maintain a uniform degree of moisture across the drier. To maintain high humidity in the receiving end, therefore, a curtain was hung so that in the upper 30% of the drier at the receiving end a positive recirculation is permitted with only a slight longitudinal movement of the air lengthwise of the drier (Fig. 2).

After the ware has passed the curtain, the air not only is recirculated but it is given a longitudinal movement. The circulating fans, *A* (Fig. 1), thus drive the heated air down through the brick setting at a high rate in the discharge end of the drier, and

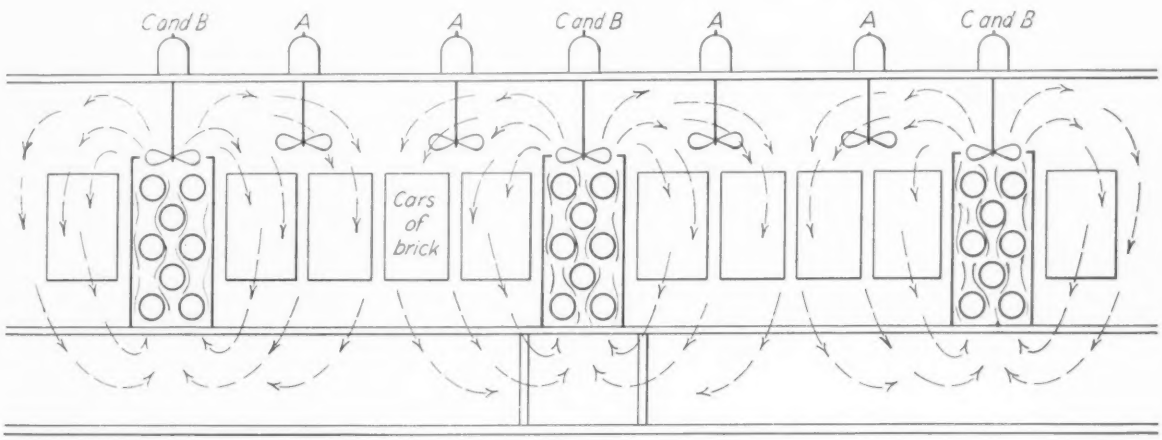


Fig. 1.

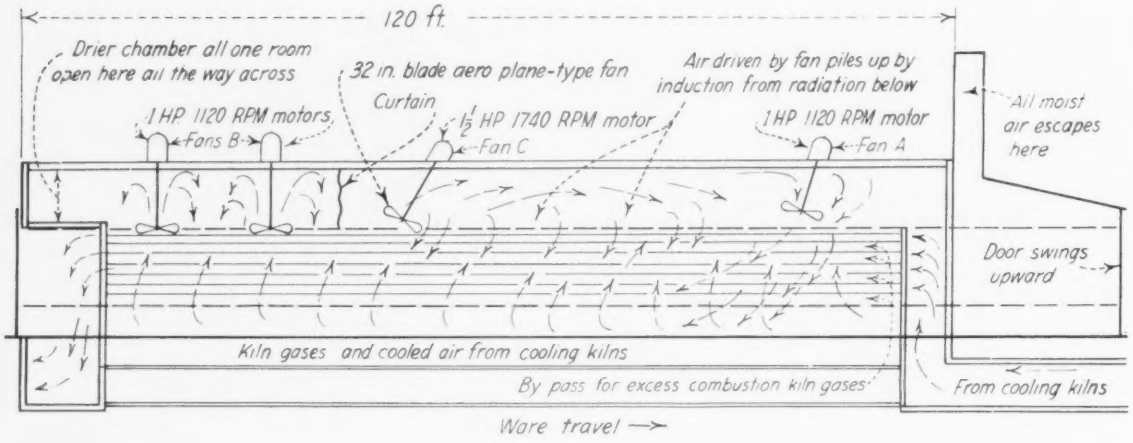


FIG. 2.

circulating fans, *C*, induce the air to move more rapidly past the heating bank.

A wet- and dry-bulb automatic control with compressed-air, diaphragm lever motors is used so that the dry-bulb control provides means of by-passing any excess heated gases not required to maintain a correct temperature. By-passed gases flow directly into the header which collects all cooled gases from the radiating tubes and passes them into the induction fan. When the humidity in the drier rises above a predetermined degree, the wet-bulb control operates the lever air motors on the control valves located below the drier car tracks. These valves are located in the cross header, which receives the cooled waste gases from the heating tubes, and they control the flow of the small amount of air of high humidity from the preheating section of the drier into the exhaust fan.

The wet-bulb control is set to maintain a desired humidity by causing more air to move into the discharge end of the drier if the humidity tends to rise above a necessary saturation. Because all air removed from the drier has a humidity of 50 to 70%, the heat is used more efficiently by this drier than in driers that allow the air to be exhausted at low humidity. Experience has proved that the air condition most suitable for drying in the receiving end is around 65% humidity at 130°F.

The exhaust fan handles the air from the cooling kilns and the kiln waste gases. A 10-h.p. motor driving the fan at the exhaust end is required for a 20-track drier (this is believed to be a minimum amount of power). The uniform draft secured for the kilns capable of producing 1000 tons of finished ware per week is a real advantage in producing uniform ware. The proper cooling of the kilns is incidental to the advantage of the kiln draft. This exhaust fan maintains approximately 0.20-inch negative water suction and gives an effective draft of 0.03 inch less at the kiln flue. The friction loss in this system therefore is very low.

The kilns are operated during most of the firing period at 0.08 to 0.09 inch of water draft, but a higher draft is available when it is necessary to flush out excessive moisture in a water-smoking kiln.

III. Advantages of Drier

The drier has a decided advantage because substantially all circulating air is moved in a direction more or less vertical, which greatly reduces differential strains in drying hollow ware.

An additional advantage gained is due to the fact that pure air comes in only at the discharge end of the drier. This air acquires some added temperature from the cooling ware, which heat generally is wasted. The incoming air, which progresses toward the receiving end of the drier, slowly gathers moisture; this moisture, in turn, adds to its capacity to carry heat from the radiating surfaces to the ware because water-saturated air compared to dry air has a heat-carrying capacity of about 300% at any temperature. Pure air free from kiln gases makes working conditions in the drier pleasant and eliminates drier-car replacements usually required because of the corrosive action from sulfurous gases in the direct waste-heat type.

A further advantage of the location of the radiating tubes above the track level is apparent for the collection of soot is unavoidable. This is readily removed by a flue cleaner of the proper size, operated from either end of the bank of radiating tubes. It is necessary to clear the flues about every eight weeks. The time required is approximately five hours for seven men for a 20-track drier. The receiving end of the drier has no outside open receiving chamber such as is used in so many waste-heat driers. The receiving end of the drier therefore may be entirely closed for operation in severe weather, which effects a saving in heat.

IV. Conclusions

The recirculating design used in this drier which provides for repassing the air several hundred times is correct in principle. The entire charge of ware on the

cars dries practically uniformly, which is an advantage. A direct waste-heat drier furthermore may be used only when the humidity is held down to avoid scumming.

This drier may be refined in construction but, compared with driers which do not provide recirculation, the low cost of operation and the correct direction and distribution of recirculating air have proved its value in practical use at the plant of the Adel Clay Products Company, Redfield, Iowa.

STRAIGHT ENGINEERING COMPANY
ADEL, IOWA

BENEFICIATION OF SOME ALABAMA GLASS SANDS*

BY R. F. HAVELL AND T. N. MCVAY†

ABSTRACT

Because a potential supply of most raw materials for making glass may be found in the Mobile area, studies were made on the beneficiation of some beach sands located southeast of Mobile on the Gulf of Mexico in the southern end of Baldwin County, Alabama. Tests show that by tabling (1) the iron content may be lowered from a range of 0.093 to 0.169% Fe_2O_3 to 0.057 to 0.066% Fe_2O_3 through the removal of iron-bearing minerals; (2) the grain-size distribution of the sands is satisfactory for glass manufacture; and (3) it may be possible to recover small amounts of zircon, kyanite, ilmenite, and rutile as by-products

I. Introduction

The purpose of this investigation was to attempt to prepare a glass sand from the beach sands of south Baldwin County, Alabama. The sands are located between Bon Secours Bay and the Gulf of Mexico, southeast of Mobile (Fig. 1).

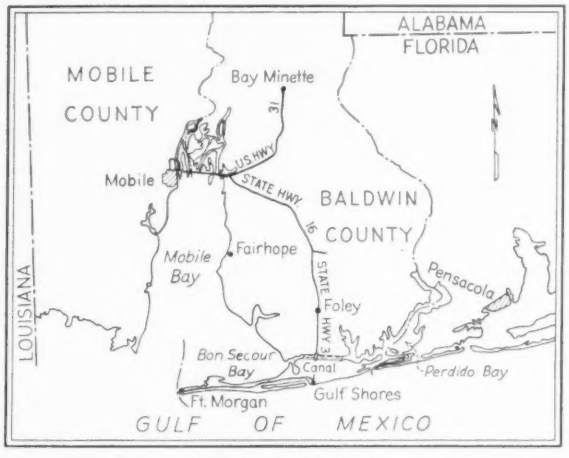


FIG. 1.—Map of the Mobile area.

Four sands were examined, viz., shore, dune, canal, and canal bank. The canal sand was dredged out of the intercoastal canal which runs through the deposit. The canal-bank sand comprises the larger proportion of the deposit because the shore and dune sands extend only a short distance back from the shore line.

According to Jones,[1] the deposit has a thickness of about 20 feet or more, and most of it will average from 5 feet above to 15 feet below sea level. Production, therefore, would be by dredging. The deposit is traversed from end to end by an intercoastal canal that would furnish an ideal means of transportation. No work has been done on these deposits up to the present time.

Other raw materials available for glassmaking include natural gas, coal, dolomite, and soda ash. The natural gas is supplied from the Louisiana fields, and producer gas could be made from steam coal from the Birmingham district Ketona dolomite with a ferric oxide content of 0.20 to 0.30% could also be obtained from the Birmingham district. Sodium carbonate is produced at Baton Rouge and Lake Charles, Louisiana, and at Corpus Christi, Texas.

TABLE I

ANALYSES OF KETONA AND COPPER RIDGE DOLOMITES*

	(1) (%)	(2) (%)	(3) (%)
SiO_2	1.25	0.33	2.13
R_2O_3	1.00†	0.44	2.63
$MgCO_3$	43.00	44.85	41.79
$CaCO_3$	54.00	55.07	52.70

(1) Ketona dolomite, Birmingham Valley, Ala.; analysis is average made on thousands of carloads.
(2) and (3) Copper Ridge dolomite, near Talladega, Ala.; analyses on grab samples.

* S. J. Lloyd, "Chemical Survey of the Birmingham District," p. 18. Pamphlet prepared for the Birmingham Industrial Board, Birmingham, Ala., 1931.

† Fe_2O_3 is from 0.20 to 0.30%.

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 18, 1939 (Glass Division). Received June 5, 1939.

† Mr. Havell is Graduate Research Assistant, School of Chemistry, Metallurgy, and Ceramics, and Dr. McVay is Professor of Ceramics and Mineralogy, Univ. of Alabama, University, Ala.

[1] W. B. Jones, "Glass Sands of Alabama," *Bull. Amer. Ceram. Soc.*, **17** [8] 327–28 (1938).

II. Procedure

The sands were washed to remove clay, twigs, or other foreign material that may have been mixed with them. The canal-bank sand contained about 20% clay. After drying, samples were taken for float-sink tests, iron determination, screen analyses, and tabling tests.

The amount of heavy minerals in each sand was determined by a float-sink test, using acetylene tetrabromide (sp. gr. 2.94) as the heavy liquid.

The size distribution of the grains was determined by screen analyses made on 10-, 14-, 20-, 28-, 35-, 48-, 65-, 100-, and 150-mesh Tyler standard sieves.

The analytical procedure for total iron in the sands was to take them into solution by a method outlined by Lundell and Knowles,[2] and the percentage of iron was determined by electrometric titration, using ceric ammonium sulfate.

The amount of iron that was dissolved when the sand was boiled in concentrated hydrochloric acid for one hour was considered to be soluble iron.

The heavy minerals in the sands were separated from the quartz by passing the sand over a Wilfley gravity concentrating table. The concentrate contained the heavy minerals and some of the finer sized sand grains and it was retabled to recover some of the fine sand. No attempt was made to split out a middling product. Table II shows analyses of these products.

Float-sink tests in acetylene tetrabromide were made on the heavy mineral concentrates (Table III) to determine the amount of heavy minerals removed and to furnish samples for petrographic examinations.

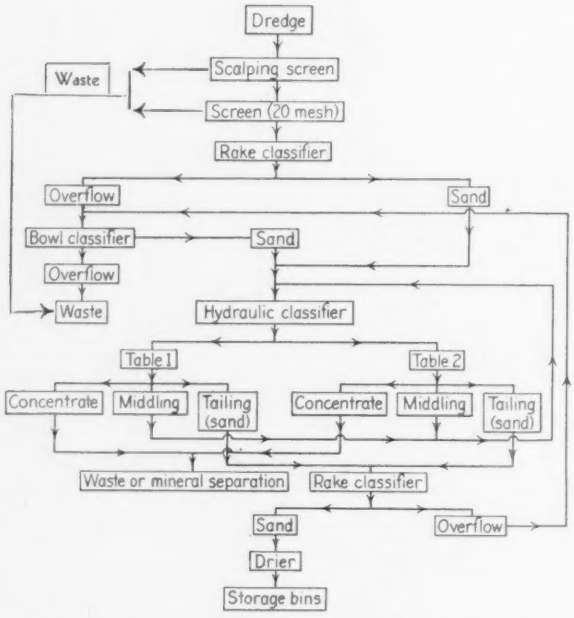


FIG. 2.—Proposed flow sheet for treatment of sands.

[2] G. E. F. Lundell and H. B. Knowles, "Determination of Iron in Glass Sands," *Jour. Amer. Ceram. Soc.*, **11** [3] 119–25 (1928).

TABLE II

	Iron analyses (% Fe_2O_3)			
	Washed sand		Tabled sand	
	Soluble (%)	Total (%)	Soluble (%)	Total (%)
Canal	0.066	0.169	0.043	0.060
Dune	0.059	0.155	0.030	0.066
Shore	0.039	0.093	0.023	0.057
Canal bank	0.057	0.115	0.030	0.065

TABLE III

FLOAT-SINK RESULTS

	Heavy minerals in feed to table (%)	Recovery of heavy minerals in concentrate (%)	Recovery of sand in tailings (%)
Canal	0.34	80	93
Dune	1.12	69	95
Shore	0.24	71	97
Canal bank	0.87	71	94

Grain counts (Table IV) were made on the heavy minerals to determine the relative amount of each of the heavy minerals in a sand. The heavy minerals from the canal-bank sand were separated with a high-intensity magnetic separator into five fractions (Table V), which ranged from nonmagnetic to highly magnetic by varying the current to the electromagnets. The minerals falling in the highly magnetic fraction were further separated by a float-sink separation in thallium formate malonate, diluted to a specific gravity of 3.2.

TABLE IV

GRAIN COUNTS ON HEAVY MINERALS

	Dune (vol. %)	Canal (vol. %)	Shore (vol. %)	Canal bank (vol. %)
Kyanite	29	21	28	28
Opaque*	27	40	28	29
Tourmaline	8	11	14	8
Staurolite	16	12	20	10
Zircon	10	10	6	22
Rutile	9	5	3	3
Pleonaste	1	1	1	0

* Opaque represents all ilmenite, leucoxene, chromite, a titanium mineral, and an iron-aluminum mineral.

TABLE V

MAGNETIC SEPARATION OF CANAL-BANK SAND

(1) Nonmagnetic: zircon, kyanite, and rutile.
(2) Very faintly magnetic: yellow opaque* and black opaque† minerals, and some zircon and rutile.
(3) Faintly magnetic: yellow opaque,* some black opaque,† and a little tourmaline.
(4) Highly magnetic, float in 3.2: tourmaline and some staurolite and black opaque†; chromium in fairly large amounts indicated by spectrograph.
(5) Highly magnetic, sink in 3.2: staurolite, some pleonaste, tourmaline, yellow opaque,* and black opaque†; chromium and manganese in quite large amounts indicated by spectrograph.
(6) Very highly magnetic: illmenite, staurolite, and a small amount of tourmaline.

* Yellow opaque mineral contains chiefly titanium with traces of iron, silicon, and some sodium.

† Black opaque mineral contains chiefly iron and aluminum and a considerable amount of titanium and silicon.

TABLE VI

SCREEN ANALYSES

Mesh No.	Cumulative % (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
10						0.0	0.0	0.0
14			0.0	0.0	0.0	0.1	0.2	0.2
20	0.0	0.0	0.1	0.1	0.3	0.4	0.7	0.9
28	0.1	0.1	1.0	1.0	2.3	2.8	3.5	4.2
35	1.0	2.2	7.9	10.8	14.7	18.2	11.8	15.4
48	52.4	53.6	51.4	63.0	50.1	56.9	32.1	40.7
65	88.2	85.7	86.2	89.6	76.0	79.2	60.1	66.5
100	99.1	99.8	99.2	99.6	91.6	95.5	85.9	93.5
150	100.0	100.0	100.0	100.0	98.4	99.5	97.6	99.5
−150	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(1) Dune sand, washed.
(2) Dune sand, tabled.
(3) Shore sand, washed.
(4) Shore sand, tabled.
(5) Canal sand, washed.
(6) Canal sand, tabled.
(7) Canal-bank sand, washed.
(8) Canal-bank sand, tabled.

The nonopaque minerals were identified with a petrographic microscope and the opaque minerals by a spectrographic examination. Samples were obtained by picking out the individual grains under a microscope using reflected light.

III. Discussion of Results

The lowering of the iron content of the sands in tabling is due chiefly to the removal of heavy minerals which contain iron.

The heavy mineral concentrate could be treated by flotation to remove and separate the ilmenite, rutile, kyanite, and zircon if the production of sand were large enough to justify the purchase of flotation equipment and reagents. These minerals may be separated by flotation according to some methods mentioned by Ralston.[3] The canal-bank sand contains about 0.9% heavy minerals; of this amount, zircon constitutes 22% and kyanite, 28%. There would be about 400 pounds of zircon, 500 pounds of kyanite, and 550 pounds of ilmenite and rutile for a production of 100 tons of sand.

There is little coarse and fine material in the sands because most of the grains are between 35- and 100-mesh, which is a desirable product for glass manufacturing purposes. The screen analyses for all of the sands are about the same (Table VI).

IV. Discussion of Proposed Flow Sheet

The flow sheet shown in Fig. 2 probably will give the best results. The location of the plant for treating the sands, however, will determine to some extent the complexity of the flow sheet. If located at the deposits, a relatively short and simple flow sheet that would give a low-recovery but high-grade product might be used because the sand is abundant and the disposal of the wastes is relatively easy. If the untreated sand were to be transported some distance to a location where the disposal of the wastes was not so easy, a more complicated flow sheet should be used to recover as much sand as possible.

Following the dredging of the sand, it should be screened to remove any wood or other foreign material and also to set an upper limit on the grain size of the sands. A rake classifier is used to remove the clay from the sand, and the overflow containing the clay and some entrained sand is treated in a bowl classifier to recover the sand. The overflow from the bowl classifier is waste, and the sand is combined with that from the rake classifier.

The most efficient tabling is obtained by using a classified feed; the sand is next treated in a hydraulic classifier, and the classified products are fed to Wilfley shaking tables. Three products are formed by the tables, viz., a concentrate which contains the heavy minerals; a middling product which contains a mixture of some of the heavy minerals and some sand; and a tailing product which is cleaned sand. The concentrate may be discarded as waste or the heavy minerals may be separated. The middlings are returned for retreatment to the hydraulic classifier, which prepares the feeds for the tables. The tailings are dewatered, dried, and put in storage.

A flow sheet that could be used at the deposit where disposal of wastes would be simple would include dredging, screening, classification to remove clay, tabling, dewatering, drying, and storage.

Acknowledgment

The authors wish to acknowledge the assistance rendered by members of the staffs of the U. S. Bureau of Mines, Southern Experiment Station, and of the Alabama State Geological Survey.

UNIVERSITY OF ALABAMA
UNIVERSITY, ALABAMA

[3] O. C. Ralston, "Flotation and Agglomerate Concentration of Nonmetallic Minerals," *U. S. Bur. Mines Repts. of Investigations*, No. 3397, 63 pp. (1938); pp. 19–20, 25–26, and 36–37; *Ceram. Abs.*, **18** [2] 59 (1939).

ACTIVITIES OF THE SOCIETY

FORTY-SECOND ANNUAL MEETING, APRIL 7–13, 1940

TORONTO COMMITTEE ON ART

The following members of the Toronto Local Committee will coöperate with the Art Division of The American Ceramic Society in the matter of providing an Art Division program during the Annual Meeting:

F. S. HAINES, *Chairman*, Ontario College of Art, 26 Grange Rd., Toronto.

MRS. MARGUERITE BAINES, President, Canadian Guild of Potters.

ROBERT J. MONTGOMERY, Ceramic Dept., University of Toronto.

CAMERON PANLIN, Ontario College of Art.

BLUE RIDGE ART DIVISION MEETING PLANS

"We are making a provision in the program of the Southern Art Institute that the ceramic section will run each afternoon throughout the entire week, July 29–August 3, 1940, rather than for two full days. This will give those who come from great distances an opportunity in the mornings to visit the various potteries that are within fifty miles of Blue Ridge. All of the people who were in the Art Group this year approved of this plan.

"I am elated over the ceramic section of the Art Conference and its success this year. We had a number of people here from long distances.

"I trust that you will continue to give us full publicity and that you will continue to work with Kenneth E. Smith, Professor of Ceramic Art at Newcomb College, on the program for the 1940 Summer Meeting."

—W. D. WEATHERFORD, *President, Institute of Southern Culture, Blue Ridge, N. C.*

Group at Blue Ridge Art Conference and Art Division meeting.

NORTHERN CALIFORNIA SECTION

The Northern California Section of The American Ceramic Society held its first fall meeting on October 2 in the Italian Room of the City Club Hotel, Oakland, Calif.

Approximately forty-five people heard T. K. Cleveland, chief chemist, Philadelphia Quartz Co. of California, Ltd., speak on "Manufacture of Sodium Silicate." Dr. Cleveland's talk was illustrated in part by lantern slides and also by a demonstration of samples of various types of sodium silicates. A general discussion followed.

December Meeting Announced

At the next meeting on December 4, election of officers for the new year will be held, followed by a Christmas party.

BALTIMORE-WASHINGTON SECTION

The fall meeting of the Baltimore-Washington Section was held at the Lord Baltimore Hotel, Baltimore, Md., October 13.

The feature of the evening was the presence of our genial General Secretary, Ross C. Purdy. Ross made this trip "to talk turkey" on the proposition of bringing the Forty-Third Annual Meeting to Baltimore. The meeting was well attended, and plans were discussed with enthusiasm.

—KENNETH M. SMITH, *Secretary*

MICHIGAN-NORTHWESTERN OHIO SECTION

The following "Proclamation" was issued by the officers of the Michigan-Northwestern Ohio Section for the first meeting of the season which was held at the German Restaurant the evening of October 13.

"Whereas there has been persistent rumor that some of our wives have become irked with being made widows by golf, boats, fishing, hunting, Polish blondes, and/or ceramic meetings and,

"Whereas it is alleged that some wives have threatened to force their respective spouses to forego one or more or all of the aforementioned pleasures and,

"Inasmuch as it appears probable that ceramic meeting attendance might possibly decline, it is hereby decreed,

"The next ceramic meeting will *not* be stag.

"It is further decreed that failure to attend said meeting shall constitute *ipso facto* evidence of guilt and persuant punishment as above outlined.

"Therefore we, the undersigned, do hereby and herein

offer a solution to or dissolution of, or possibly absolution from, marital troubles, hecklings, wrangles, rifts, disagreements, arguments, or irritations of like nature by cordially (and sincerely) inviting your wife to

"The Michigan-Northwestern Ohio Section of The American Ceramic Society at the German Restaurant, Detroit, Mich."

The officers for this Section are *Chairman*, L. G. Tait, Champion Spark Plug Co., Detroit, Mich., and *Secretary*, J. A. Foster, Ford Motor Co., Dearborn, Mich.

EUROPEAN JOURNALS AND THE WAR

The nonreceipt by a subscriber of any European chemical or other scientific journal seriously needed as research material should be promptly reported to the American Documentation Institute.

The Cultural Relations Committee of ADI, which coöperates closely with the Cultural Relations Division of the Department of State, is working on this problem and hopes to be able to surmount such war obstacles as interrupted transportation, embargoes, and censorship, which so grievously affected the progress of research during the last war.

The principle will be established, if possible, that the materials of research having no relation to war shall continue to pass freely, regardless of the countries of origin or destination.

Reports, with full details of where subscriptions were placed and names and addresses of subscribers, volumes, dates, and numbers of last issues received, should be addressed to American Documentation Institute, Bibliofilm Service, c/o U. S. Department of Agriculture Library, Washington, D. C.

PROGRESS REPORT ON THE ACTIVITIES OF A.S.T.M. COMMITTEE C-14 ON GLASS AND GLASS PRODUCTS

Report of Subcommittees

Subcommittee I, Nomenclature and Definitions: Chairman, F. C. Flint. No report.

Subcommittee II, Chemical Analysis: Chairman, G. E. F. Lundell. (*a*) *Chemical Analysis of Glass Sand.* A tentative method has been worked out and approved for publication under designation (C146-39T). The method covers analytical procedures for SiO_2, Al_2O_3, Fe_2O_3, TiO_2, ZrO_2, CaO, MgO, P_2O_5, and V_2O_5.

(*b*) *Coöperation with International Commission.* Four samples of sand were received from abroad and distributed among four laboratories for comparative analyses of iron content. Colorimetric, gravimetric, and potentiometric methods were used. Correlation of data is now being carried out.

(*c*) *Rapid Methods of Chemical Analysis of Glass.* Six coöperating laboratories have shown excellent progress in trying out some rapid methods. Approved methods may be available during the coming year.

Subcommittee III, Chemical Properties: Chairman, D. E. Sharp. (*a*) *Chemical Durability of Glass.* Several glasses have been compared for chemical durability both by the powder and surface methods. As a result of this work, another program has been set up whereby a carefully selected group of bottles will be tested under better controlled conditions. Surface durability will be continued on six different compositions of glasses, comparing autoclave tests (tests at temperatures of 95° and 100°C) with room storage conditions.

(*b*) *Durability of Color Decorations on Glass.* A subcommittee is proposed to consider durability of color decorations on glass, inasmuch as such decorations have become popular on food containers.

Subcommittee IV, Physical and Mechanical Properties: Chairman, J. T. Littleton. (*a*) *Modulus of Rupture of Glass Test Pieces.* This method of testing glass cane and flat strip will be ready for submission to the Committee during the year.

(*b*) *Polariscopic Examination of Glass Containers.* This tentative method has been approved for publication under designation (C148-39T).

(*c*) *Hydrostatic Pressure Test on Glass Containers.* Approval for publication has been obtained for this tentative method under designation (C147-39T).

(*d*) *Thermal Shock Test on Glass Containers.* This method will appear as a tentative method under designation (C149-39T) in the new Yearbook.

Subcommittee V, Thermal Properties: Chairman, E. W. Tillotson. No report.

Subcommittee VI, Glass Construction Block and Tile: Chairman, J. P. Staples. Considerable data have been collected by the producers of glass block. It is anticipated that the committee will have opportunity to review the data soon.

The tentative methods given above will all be published in the A.S.T.M. Yearbook. They are subject to review by Committee C-14 at any time.

—Louis Navias, *Secretary*

BREAKDOWN OF THE MEMBERSHIP ACCORDING TO DIVISIONS

Division	Personal	Corporation
Art	79	6
Enamel	187	36
Glass	271	39
Materials and Equipment	149	38
Refractories	424	35
Structural Clay Products	145	16
Terra Cotta	48	6
White Wares	349	58
Professors	80	
All Divisions	76	9
No Divisions	93	1
Total	1901	244

NEW MEMBERS FOR OCTOBER

Personal

Barrett, Harvey N., Jr., 845 Hanna Bldg., Cleveland, Ohio; sales and service engineer, Basic Dolomite, Inc.

Hoyt, Philip S., Clarkesville, Ga.; consulting geologist, Laclede-Christy Clay Products Co.

Knoll, William F., Box 877, New Haven, Conn.; treasurer, Montowese Brick Co., Inc.

Student

University of Illinois: Amrit K. Bhalla.
University of North Carolina: Ernest C. Hepler, Jr.
Ohio State University: Albert W. Witzemann.
University of Washington: John W. Bell.

ROSTER CHANGES DURING OCTOBER*

Corporation

National Gypsum Co., F. L. Marsh (voter), Research Dept., Clarence Center, N. Y. (Buffalo, N. Y.)

Personal

Charles, R. Gordon, 505 Lincoln Ave., Minerva, Ohio (Blacksburg, Va.)

Clark, Emory W., Georgia Kaolin Co., Dry Branch, Ga (Atlanta, Ga.)

Morris, George J., Harbison-Walker Refractories Co., Clearfield No. 2 Works Lab., Clearfield, Pa. (Sykesville, Pa.)

Polivka, J., Engineering Materials Lab., Univ. of California, Berkeley, Calif. (Astoria, L. I., N. Y.)

Simpson, F. J., 145 Glendale Ave., Toronto, Ont., Canada (Regina, Sask., Canada)

Solomon, Victor J., Box 745, High Point, N. C. (Louisville, Ky.)

* Address in parentheses is former address.

MEMBERSHIP WORKERS' RECORD FOR SEPTEMBER AND OCTOBER

Corporation

Office	1

Personal

A. I. Andrews	2	Frederick Heath, Jr.	1
W. F. Curtis	1	M. E. Holmes	1
Samuel Geijsbeek	1	Vera O. Neff	2
A. F. Greaves-Walker	1	J. T. Ogden	2
J. F. Greene	1	R. G. O'Meara	1
J. S. Gregorius	1	Anna O. Shepard	1
R. E. Hanna	1	Office	5

Student

A. I. Andrews	3	Nelson W. Taylor	1
R. M. Campbell	1	Pickett Turner, Jr.	1
M. E. Holmes	1	Carl H. Zwermann	1
W. W. Kriegel	1	Office	2
Ernest B. Snyder	1		

Grand Total 34

SCHOOL NOTES

MISSOURI SCHOOL OF MINES

The officers of the Missouri School of Mines Student Branch for 1939–1940 are *President*, W. J. Smothers; *Vice-President*, Joe Hoffman; and *Secretary-Treasurer*, Ivan Niedling.

The initial meeting of the new school term was held September 20, 1939, with President W. J. Smothers presiding. Marvin Pingel, a member of The American Ceramic Society, described his experience of two and one-half years in the enamel department of the Benjamin Electric Co., Des Plaines, Ill. He explained various procedures, methods, and apparatus used in the plant.

After the talk, each student told of his experiences during the past summer. These were many and varied and showed the various abilities of the members.

Dr. Herold, head of the Ceramic Department, gave a short talk and introduced Chester E. Henderson, the new member of the ceramic staff. Professor Henderson has been working in the glass industry for a number of years and intends to offer work along these lines.

This year no doubt will prove to be one of the most successful in the history of this group. Approximately thirty members were present, and this Student Branch is showing increased growth and activity.

—Ivan Niedling, *Secretary*

C. E. HENDERSON JOINS SCHOOL STAFF

C. E. Henderson has joined the ceramic staff of the Missouri School of Mines and Metallurgy for the school year, 1939–1940. He was graduated from Ohio State University in Ceramic Engineering and has had a varied experience in the sheet- and plate-glass industry. He has been in the research department and has been assistant general manager of the Pittsburgh Plate Glass Co.; factory manager for the Libbey-Owens Glass Co.; consulting engineer for the American Window Glass Co.; and finally plate-glass assistant manager with the Ford Motor Co. Mr. Henderson holds several patents on plate glass.

WPA POTTERY PROJECT AT MISSOURI SCHOOL OF MINES

The WPA has established a pottery project at the Missouri School of Mines and Metallurgy, Rolla, Mo., appropriating $11,500 for the project. The work is to be under the sponsorship of H. H. Buehler, Missouri Geological Survey, in coöperation with Paul G. Herold, Ceramic Engineering Department, School of Mines.

The purpose of the project is to develop the use of Missouri raw materials for the manufacture of pottery and to develop new designs for ceramic ware. Clays to be used will be obtained from deposits which have not been commercially developed in southeastern Missouri. The ware to be produced will be used in the visual aid education, nursery, housekeeping-aid, and school-lunch projects sponsored by the WPA.

The supervisor in charge of the project will be Stuart Dods of Kansas City, Mo., a recent graduate of the Ceramic Engineering Department at Rolla.

NEW YORK STATE COLLEGE OF CERAMICS

The officers of the New York State College of Ceramics Student Branch for 1939–1940 are as follows: *President*, Frank Arrance; *Vice-President*, Stephen Day; *Secretary*, Bernhard Gentsch; and *Treasurer*, William Drohan.

The first meeting of the school year was held on October 10. W. R. Kerr, director of research of the Armstrong Cork Company, spoke on "High-Temperature Insulation."

As a part of the registration week activities, the freshmen met with the Ceramic College faculty. The program and activities for the year were outlined. At the conclusion of this meeting, M. E. Holmes, Dean of the College, introduced representatives of the Student Branch and of Keramos, who explained the function of these organizations.

—Bernhard Gentsch, *Secretary*

OHIO STATE UNIVERSITY

The officers of the Ohio State University Student Branch for 1939–1940 are as follows: *President*, Howard Petty; *Vice-President*, Richard Kelting; *Secretary-Treasurer*, Donald Postlewaite; *Engineering Council Representatives:* Senior, Bob Newton; Junior, Ted McQuaide.

For the first meeting of this group, a "Clay Mixer" get-acquainted affair was held Tuesday, October 17, at Lord Hall. The following program of talks was given:

"The American Ceramic Society and Ceramic Education," by R. C. Purdy, General Secretary.

"The Engineering Experiment Station and Ceramic Education," by G. A. Bole.

"The Ceramic Engineering Department, Ohio State University," by A. S. Watts, J. L. Carruthers, and R. M. King.

"The Ceramic Art Department, Ohio State University," by A. E. Baggs and Edgar Littlefield.

Following the election of officers, refreshments were served.

UNIVERSITY OF ILLINOIS

The officers of the University of Illinois Student Branch for 1939–1940 are as follows: *President*, V. J. Cichowski; *Vice-President*, J. W. Briscoe; *Secretary*, R. R. Rough; and *Treasurer*, R. E. Whitfield.

The first meeting of the Student Branch was held on October 6, 1939. This was an organization meeting at which plans were discussed for the school year. There was a record attendance, and the students were enthusiastic in taking part in the Student Branch activities.

Monthly meetings are scheduled for the school year, and there will be two meetings in May.

The annual dance, "Ceramic Ruckus," will be held on November 18, and the annual banquet, "The Pig Roast," will be held sometime in May.

The chairmen of the different committees making plans for the year are as follows: John Briscoe, "Pig Roast," and "Ceramic Ruckus" Business Manager; Charles Hanks, "Ceramic Ruckus" Program Committee; George Eyerly, Editor, "Illini Ceramist" yearbook; H. M. Killmar, "Illini Ceramist" Business Manager; H. Swift, Refreshments Committee; R. E. Wolfensperger and T. Willmar, Athletic Committee; and Charles Van Etten and M. S. Thorson, Committee on Raw Materials.

—Val J. Cichowski, *President*

GEORGIA SCHOOL OF TECHNOLOGY

At a meeting of the Student Branch at the Georgia School of Technology held on September 22, the following officers were elected for 1939–1940: *President*, Harold Dye; *Vice-President*, Edward Epstein; *Treasurer*, Leon Nunes; *Secretary*, Joseph Albert; and *Councillor*, Lane Mitchell.

The sophomores were invited to a meeting on the evening of September 27. Warren Johnson of the Spode China Company spoke and showed a motion picture of the Spode works in England.

President Dye called on W. H. Vaughan, head of the Department of Ceramic Engineering, and Lane Mitchell, Charles F. Wysong, Julian Harris, and Technician L. A. Tedder, professors of the department, to make a few remarks; a wiener roast was held later in the kiln room.

An initiation of the sophomores, eighteen in number, was held the week of October 2.

—LANE MITCHELL, *Councillor*

PENNSYLVANIA STATE COLLEGE

The officers of the Pennsylvania State College Student Branch for 1939–1940 are as follows: *President*, Bruce Trumm; *Vice-President*, Joseph D'Amico; *Secretary-Treasurer*, Stanley H. Young; and *Councillor*, Edward C. Henry.

At the meeting held on October 2, Dean Edward Steidle spoke on "A Trip Along the West Coast of South America." A social meeting followed.

On October 14, Walter A. Weldon, Locke Insulator Corp., Baltimore, Md., spoke on "The Origin of the Name 'Porcelain.'" This talk was illustrated with charts and maps, pieces of Chinese ceramic art, and work of Mr. Weldon's own studios.

IOWA STATE COLLEGE

The officers of the Iowa State College Student Branch for 1939–1940 are *President*, V. L. Plagge; *Vice-President*, Martin Baker; and *Secretary-Treasurer*, Lloyd Wells.

There are thirty members of this Student Branch, some of whom are members of the national Society.

The members held a fall "get-together" picnic near the campus on October 5, 1939. The purpose of the picnic was to enable the new and old students to become acquainted and for the students to meet socially the new department head, C. M. Dodd, and the new instructor, H. J. Beckemeyer, a graduate of the University of Illinois.

The laboratories of the Ceramic Engineering Department at Iowa State College are undergoing a complete change. New laboratory equipment has been installed for the physical testing of clays and ceramic products. The clayworking machinery has been rearranged to enable the students to carry out laboratory experiments. The old kiln room has been eliminated and turned into a grinding room. A new kiln is being built, and the car kiln will be moved to a new location. The entire department is being painted. The laboratories have increased in efficiency and present a much better appearance.

—MAURICE W. GORMLY, *Publicity Chairman*

VIRGINIA POLYTECHNIC INSTITUTE

The officers of the Virginia Polytechnic Institute Student Branch for 1939–1940 are as follows: *President*, Wade H. Hitt; *Vice-President*, O. J. Parker; *Secretary-Treasurer*, K. S. Haff; and *Councillors*, P. S. Dear and John W. Whittemore.

RUTGERS UNIVERSITY

The officers of the Rutgers Ceramic Club and Student Branch for 1939–1940 are as follows: *President*, Robert R. Brooks; *Vice-President*, Robert I. Owen; *Secretary*, George E. Pearce; *Treasurer*, Clarence H. Hill; and *Corresponding Secretary*, Gilbert Goodman.

—GILBERT GOODMAN, *Corresponding Secretary*

NECROLOGY

CHARLES L. NORTON

Charles Ladd Norton, for forty-six years a member of the faculty of the Massachusetts Institute of Technology, died at his summer home in Annisquam, September 8,1939.

C. L. Norton was born in Springfield, Mass., in 1870, the son of Francis and Jennie Maria Norton, and was graduated from the Institute in 1893. In the same year, he became a member of the staff of its department of physics, and for the remainder of his life he maintained an uninterrupted affiliation with Technology. He held at various times the posts of Professor of Heat Measurement and Industrial Physics, Director of the Research Laboratory of Industrial Physics, Head of the Department of Physics, member of the Administrative Committee of the Institute in 1922, and since 1921 he had been Director of the Division of Industrial Coöperation.

He was associated with the late Edward Atkinson in pioneer fire prevention work. He was influential in the introduction of Portland cement concretes as a material for fireproof construction, and he was the inventor of processes used largely in the manufacture of asbestos wood and shingles. This last industrial contribution was perhaps his best-known invention, and the familiar asbestos materials in such wide use today are largely the result of his research. He further developed processes for the manufacture of metallic magnesium, particularly for use during the World War.

C. L. Norton

Among Professor Norton's notable contributions to industry was a machine for making silica brick which superseded the old hand-molding method and is now in universal use. He had also contributed to the knowledge of high-temperature insulating materials and was much interested in problems of corrosion in metals. Recently he had been engaged in important research on synthetic textile fibers.

Professor Norton was a pioneer in the application of X rays to medicine and surgery in this country and was distinguished for early investigations in this field with the late Francis H. Williams of Boston. His published papers, beginning with "The X-Rays in Medicine and Surgery," published in 1896, range over almost the entire field of industrial physics and number more than fifty. He held over one hundred United States and foreign patents.

He was a Fellow of the American Academy of Arts and Sciences and a member of the American Physical Society the American Chemical Society, the American Association for the Advancement of Science, the American Society of Mechanical Engineers, The American Ceramic Society (since 1923), the Society for the Promotion of Engineering Education, the National Fire Prevention Association, and the American Society for Testing Materials.

Professor Norton is survived by three sons and three daughters.

EFFECT OF EUROPEAN AND ASIATIC WARS ON YOUR CERAMIC SOCIETY

(1) At present no effect is evident.

(2) Plans for holding the 1940 Annual Meeting in Toronto are being continued on assurances from the Canadian and Ontario governments and from the Toronto Chamber of Commerce as well as from the manager of the Royal York Hotel that meetings and exhibits may be held with the customary facilities.

(3) All business transactions with European and Far East ceramists, both secretarial and editorial, are continuing without any suggestion of a change.

What About the Future?

(1) But men, money, and endeavors cannot be wasted on war without seriously jeopardizing all plans and facilities for cultural and industrial progress. This Society will lose a considerable amount of the coöperative support which it has had from European and Asiatic members. Membership fees and subscriptions in 1939 from these ceramists totaled $7541.90. No one can foretell what shrinkage there will be in this income.

(2) There is the one certainty that though there should be no great shrinkage in fees and subscriptions from our ceramic friends abroad, there must be a larger supporting subscription from American ceramists if The Society is to meet the present-day demands for published information on ceramic research.

(3) Ceramic Corporations in larger numbers will pay a minimum sustaining fee of $25.00 if they are personally approached.

(4) The officers, committeemen, and members are encouraged with the paid Membership Record for 1939 as shown here, but this record must be bettered.

The losses from abroad that will be certainties in 1940, owing to wars, must be anticipated and covered by an increase in our domestic membership. Please help your committeemen make this increase possible so that The Society activities will not have to be curtailed.

1939 PAID MEMBERSHIP RECORD

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 19, 1938	1815	222	26	589	220	2872
January 21, 1939	1792	220	26	610	220	2868
February 18, 1939	1795	225	25	620	220	2885
March 30, 1939	1808	229	23	648	220	2929
April 18, 1939	1641	226	58	596	220	2741
May 20, 1939	1710	231	43	611	220	2815
June 16, 1939	1739	232	42	617	220	2850
July 17, 1939	1753	233	39	626	220	2871
August 22, 1939	1786	233	37	615	220	2891
September 30, 1939	1816	235	35	630	220	2936
October 23, 1939	1825	235	33	631	220	2944

BREAKDOWN OF EUROPEAN AND ASIATIC MEMBERSHIPS AND SUBSCRIPTIONS THE AMERICAN CERAMIC SOCIETY

Country	Subscribers	*Bulletin* only	Members		Library with agent	Library or agent	Regular subscribers
			Personal	Corporation			
Australia	11	1	10	1	3	7	1
Belgium	10		2			6	4
China	13		7		5	8	
England	29	1	83	5	3	15	11
Finland	2					1	1
France	9		12	2		5	4
Germany	29		33	1	5	16	8
Holland	7		9			5	2
India	10		11	1	3	6	1
Italy	16		3		2	13	1
Japan	83	2	10	3	15	68	
Mexico	2	2	4				2
Scotland	3		11			3	
South Africa	3		7	1	1	1	1
U.S.S.R.	96	12	2		44	45	7
Ireland				1			
Cuba		1	1				
Denmark	4		3			2	2
Poland	3		3	1	1	1	1
South Iran	1						
Spain			1			1	
Siam	1					1	
Sweden	4		7			4	
Portugal	1					1	
New Zealand	1					1	
Wales	1				1		
Philippine Isles	1			1	1		
Czech-Protectorate			2				
Hungary			1				
Latvia			1				
Norway			3				
Rumania			1				
Porto Rico			2				
Switzerland	1	1	1				1
Total	341	20	230	17	84	210	47

47 subscriptions	@ $15.50	$ 728.50	
210 subscriptions	@ 12.50	2625.00	
84 library subscriptions	@ 10.10	848.40	
341		$4201.90	
20 *Bulletin* subscriptions	@ 2.00	40.00	
361 total foreign subscriptions			$4241.90
230 Personal members	@ 12.50	2875.00	
17 Corporation members	@ 25.00	425.00	3300.00
Total Income Foreign Memberships and Subscriptions			$7541.90

NOTES AND NEWS

PORCELAIN ENAMEL INSTITUTE FORUM

More than 200 members of the porcelain enameling industry, together with representatives of manufacturers in such allied lines as iron and steel, gas and electrical appliances, chemicals, and signs, attended the Fourth Annual Forum of the Porcelain Enamel Institute, October 18 to 20, at Ohio State University, Columbus, Ohio. All sections of the country were represented as well as visitors from Canada, Brazil, and India.

The opening session consisted of a "Symposium on the Fine Grinding of Enamels," a departure this year from the usual presentation of set papers. Improvements in the quality of porcelain enamel have been made by finer grinding of the raw material before its application and firing. E. C. Aydelott, Benjamin Electric Mfg. Co., led this discussion, assisted by E. W. Dietterle, American Stove Co., C. T. Gordon, Porcelain Metals Corp., J. B. Simon, Westinghouse Electric & Mfg. Co., Norman Stolte, Enamel Products Co., and G. E. Terry, Edison General Electric Appliance Co.

Fine grinding of enamels requires marked improvement in the quality of ground-coat application so that the thinner cover coats will not be adversely affected. Fine grinding has a marked influence on colors, requiring an entirely new processing schedule with different variation in the time-temperature cycle; gloss and other surface characteristics are also affected.

One of the most significant of the Forum sessions was that on "Architectural Enameling." With the gains recently made in the sale of porcelain enameled store fronts and other architectural parts, the papers presented in this session went beyond the immediate problems of the enameling shop.

A. C. Weierich, Davidson Enamel Products, Inc., opened this session with a discussion of "What the Jobbing Shop Must Do to Handle Architectural Work." The architect's viewpoint was expressed by W. S. Arrasmith, of Wischmeyer, Arrasmith & Elswick, Louisville architects, who stated that, although porcelain enameled steel clearly has an excellent future as a building material, it has not has been sufficiently "sold" to architects and to the consumer.

The Thursday morning session on "Sheet Iron and Hollow Ware" included a talk on drawing compounds by G. W. Dykstra, Kelvinator Division of Nash-Kelvinator Corp., and a paper by E. H. Shands, George D. Roper Corp., on "Use of Softened Water in Cleaning and Pickle Room Practice."

One of the most pertinent subjects of the meeting was presented at the final session by R. F. Bisbee, Westinghouse Electric & Mfg. Co., who discussed "Inspection, Packing and Field Problems of Porcelain Enameled Products." He described the detailed system of inspection on suppliers' products employed by the Westinghouse Co. in its Mansfield enameling plant.

Some materials are checked by a sampling method as received, some require spot checking, while others must have 100% checking, the latter in cases where the ability of a supplier to meet the inspection standards consistently is in doubt. The use of such inspection should be a preventative rather than a cure of ills arising in the processing. Steel is checked on four major counts, surface and gauge, drawing qualities, bond adhesion, and sag; the sag test used is closely comparable to the test now being proposed by the Institute as a standard for the industry.

Suppliers of several materials, including steel, are regularly graded on performance of their materials as they go through the enameling shop, for the protection and information of both the supplier and the purchasing department of the company.

Mr. Bisbee outlined the development in recent years of improved packing methods and much better crating of porcelain enameled products designed to maintain them in satisfactory condition during shipping and in the field. One of the most useful devices is a "shock test" used at the factory to determine accurately whether an appliance is so constructed as to withstand the shocks that occur in transportation.

At the annual Forum banquet meeting, William E. Wickenden, president of the Case School of Applied Science, delivered an address on "Applied Arithmetic—Division or Multiplication?" Dr. Wickenden's thesis was that American prosperity depends on a multiplication of the nation's assets through raising the standard of living, rather than on the division of national income by means of legal and political restrictions. Bennett Chapple of the American Rolling Mill Company presided as toastmaster, and J. E. Hansen of the Ferro Enamel Corporation introduced Dr. Wickenden.

NEW YORK SOCIETY OF CERAMIC ARTS

The New York Society of Ceramic Arts held a meeting at the Metropolitan Museum of Art on October 25. Wheeler Williams addressed this group upon the subject, "Ceramics, Its Relation to Sculpture."

Mr. Williams is an associate of the National Academy, a member of the Council of the National Sculpture Society, and Vice-President of the Architectural League of New York.

Born in Chicago, now a resident of New York, Mr. Williams is a graduate of Yale and received his Master's degree in architecture at Harvard. He has created outstanding work in practically every field of sculpture and in all mediums.

Among his works as an animalist are included a statuette of the world's champion Jersey, "Cherokee, the Famous Jumper," the black panthers of Brookgreen Gardens, and the sea lion fountain in Regent's Park, London.

In the architectural and monumental fields, Mr. Williams has won the international competition for the pediment of the National Library of Brazil, and he has designed the west pediment of the Interstate Commerce Building in Washington, the Tablets to the French Explorers on the Michigan Avenue Bridge in Chicago, the terra-cotta mural in the new Canal Street Post Office in New York, and the heroic four "Steeds of the Imagination" on the tower of the Reader's Digest at Chapaqua, N. Y.

In portraiture, he has executed over one hundred busts and reliefs in all mediums, but chiefly in terra cotta, and nearly half of these for clients in Paris and London. He has also designed sundry medals in the field of education.

Mr. Williams has taught figure and composition classes at the Beaux-Arts Institute of Design. He was offered the post of Director of Sculpture at the San Francisco World's Fair.

Curiously, he is not represented at the New York World's Fair except by seven pieces not designed specifically for it. He was commissioned to do the sculpture for the Fisheries Building, but this was sold to a private concern for which his models were inappropriate in subject, and these models accordingly were never executed at full scale.

Mr. Williams showed slides of various terra-cotta sculptures and a film showing the execution and direct firing of a portrait head in the eighteenth century technique. As far as he knows, he and Paul Manship are the only artists employing this method, which permits firing the original clay model instead of a molded replica. The result is not only the actual original, but it cannot be duplicated at the same size. Incidentally, the danger of cracking or warping is practically eliminated.

A period for discussion followed the address.

LALOR FOUNDATION FELLOWSHIPS

The Lalor Foundation, of Wilmington, Del., has announced the program for the fourth series of fellowship awards, authorizing grants to the total amount of $20,000 for the academic year 1940–1941. The individual awards are scheduled to range between $1800 and $2500 or according to the special needs of the candidate.

Six fellowships of the 1939–1940 series are being currently administered by the Foundation, which was organized in 1935. The work of the holders of present fellowship awards is in the fields of physical chemistry, biochemistry, and biophysics, and the institutions at which the researches are currently being conducted include Oxford University, in England; and Cornell University, Princeton University, Johns Hopkins University, the Massachusetts Institute of Technology, and the Johnson Institute of Biophysics of the University of Pennsylvania, in the United States. The present war has caused almost complete abandonment of fundamental research in the belligerent countries, but in spite of the emergency the fellows originally scheduled to work abroad have been able to make other equally satisfactory plans for the coming year.

The awards in the 1940–1941 series will be given for fundamental research work in any field of chemistry. Support for industrial research is not intended. The awards are open both to men and women and for work anywhere in the United States or abroad. Men and women in academic service who may be on sabbatical leave or other leave of absence are among those eligible for appointment. Attainment of the degree of Ph.D. or training equivalent thereto is a requirement for candidacy. The final selections will be based on the previous training, demonstrated competence, and promise of the candidates in their special fields of work.

Preference will be given to candidates directing their research and studies toward applying the principles and discoveries of physical and organic chemistry to problems within these latter fields.

The qualifications of candidates will be passed upon by a Selection Committee consisting of C. A. Kraus, Brown University; Arthur B. Lamb, Harvard University; Roger Adams, University of Illinois; Hans T. Clarke, Columbia University; and the Secretary of the Foundation.

Inquiries and requests for application forms for awards should be addressed to C. Lalor Burdick, Secretary, Lalor Foundation, Wilmington, Del., not later than December 31, 1939. Appointments will be announced early in March, 1940.

AIR HYGIENE FOUNDATION OF AMERICA, INC.

The Fourth Fall Meeting of the Air Hygiene Foundation was held November 14 and 15, 1939, at Mellon Institute, Pittsburgh, Pa.

Roger A. Hitchins, Chairman of the Board of Trustees, and E. R. Weidlein, Director of Mellon Institute, opened the meeting.

The following papers and discussion topics were presented: (1) "Foundation Activities in 1939"; (2) "Review of Recent Occupational Disease Legislation"; (3) "Report of the Preventive Engineering Committee"; (4) "Labor's Viewpoint on Occupational Disease Prevention"; (5) "Report of the Medical Committee on Foundation Research"; (6) Symposium on "Sick Absenteeism in Industry"; (7) "Employer's Viewpoint on Industrial Health;" and (8) Forum on "Impact of Employee Health on Industrial and Public Relations."

EIGHTH NATIONAL CERAMIC EXHIBITION PRIZE AWARDS ANNOUNCED

The winners of the prize awards for the Eighth National Ceramic Exhibition have been announced by Anna Wetherill Olmsted, Director of the Syracuse Museum of Fine Arts, Syracuse, N. Y. Nearly 300 pieces of ceramic art were submitted for this Exhibition by 113 contributing artists.

In the Foreword of the Exhibition catalog, Dorothy Liebes, Chairman of the Jury, writes as follows:

"The Jury was impressed with the dignity and maturity of the ceramists' work—qualities which do not interfere with the spontaneity, freedom of expression, and humor found in the ceramic sculpture and pottery selected for the Eighth National Exhibition.

"There is less of the European tradition appearing in this field of American art and craftsmanship and more feeling for the imaginative possibilities of this most ancient of arts.

"The National Ceramic Exhibition is perhaps the most unself-conscious' art exhibition in America at present; for, without propaganda, ceramists are devoting themselves to the essentials of form, color, and texture, and their work, both utilitarian and decorative, is a personal expression. They are not burdened with 'ideologies,' proletarian or otherwise, which act as a restriction on creative ideas.

"In making awards, great weight is given to creative ability. The Jury this year, according to a new policy which abolished graded prizes and secondary mentions, made eleven Awards of Merit for distinguished work. The Jury then recommended that seven Purchase Prizes be given to members of this group, their work to go to the permanent collection of the Syracuse Museum, which organized the first National Ceramic Show in 1932.

"The Jury further recommended a Special Award of Recognition to Waylande Gregory for his work in outdoor ceramic sculpture commissioned for the New York World's Fair."

The awards are as follows:

(1) Thelma Frazier, Cleveland, Ohio, $100 Purchase Prize for sculpture given by the Hanovia Chemical & Mfg. Co., Newark, N. J., for work entitled "Night with the Young Moon."

(2) Gertrud and Otto Natsler, Los Angeles, Calif., (exhibiting for the first time) $100 Purchase Prize given by the Onondaga Pottery Co., Syracuse, N. Y., for a group of five pieces.

(3) Henry Varnum Poor, New York, N. Y., $100 Purchase Prize given by the Ferro Enamel Corp., Cleveland, Ohio, for a platter entitled "Nude."

(4) Harold Riegger, Perry, N. Y., $100 Purchase Prize given by the Harshaw Chemical Co., Cleveland, Ohio, for a tall brown stoneware bottle, unglazed.

(5) Sascha Brastoff, New York, N. Y., $50 Katherine Q. Payne Memorial Award for two figures entitled "Emergence" and "Timid Maiden."

(6) David Seyler, Cincinnati, Ohio, $50 Purchase Prize given by the B. F. Drakenfeld Co., New York, N. Y., for a clay portrait entitled "Portrait of Jack Chasnoff."

(7) Karl Drerup and Josef V. Tury, New York, N. Y., $50 Purchase Prize given by the E. I. du Pont de Nemours & Co., Wilmington, Del., for vase entitled "Shepherd."

Glen Lukens, Los Angeles, Calif., Charles Harder, Alfred, N. Y., Mary Yancey Hodgdon, Fullerton, Calif., and Irene Aitken, Cleveland, Ohio, received Awards of Merit.

The Jury awarded no prize for work in enamel this year. Although interesting work was submitted, it did not reach the high standard set in former years, and the Jury believed it to be a healthier policy not to give any award under these circumstances.

For the announcement of the 1939–1940 circuit and other information on this Exhibition see *The Bulletin*, October, 1939, p. 403.

The annual National Ceramic Exhibition was founded in 1932 in memory of Adelaide Alsop Robineau.

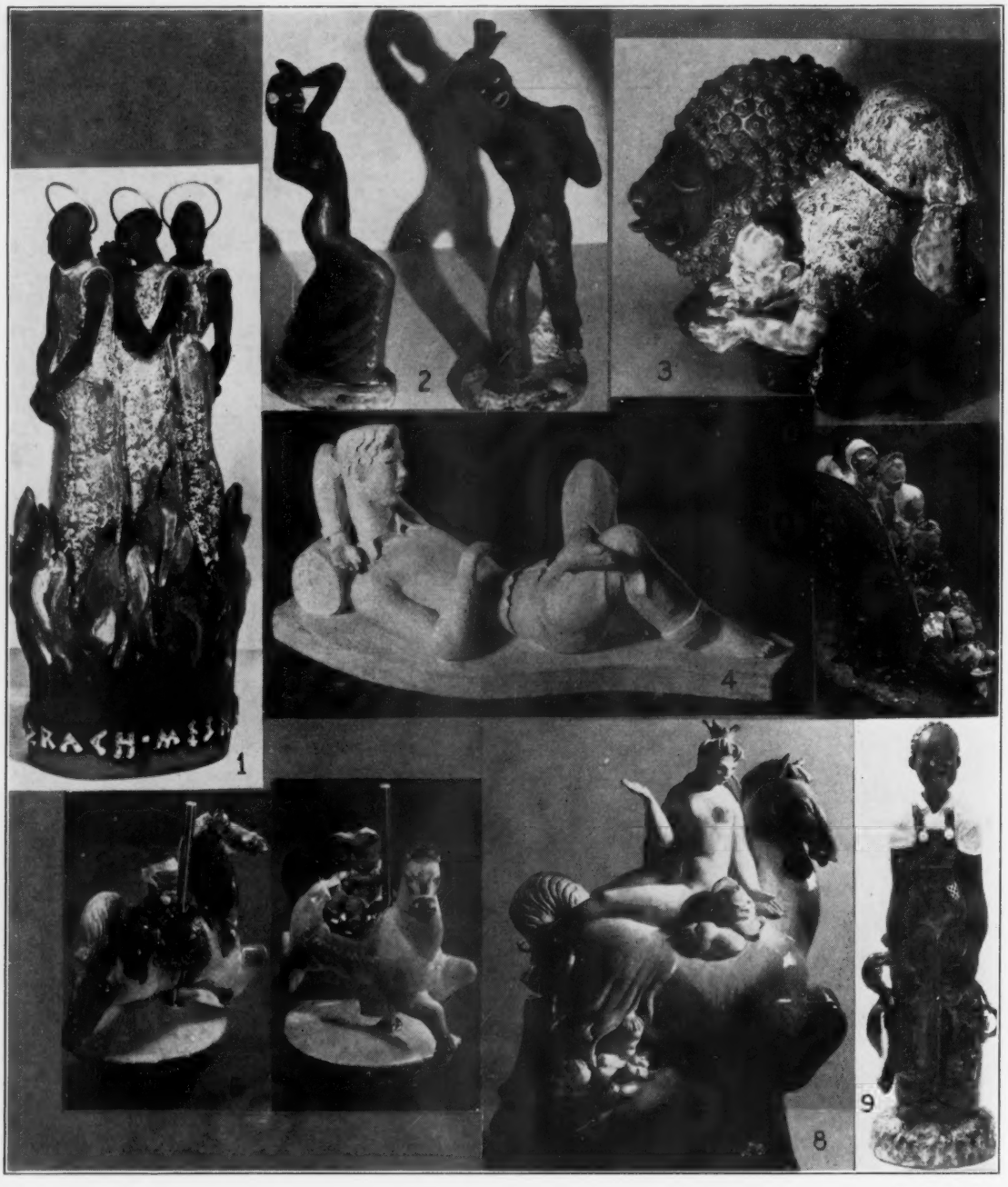
GROW BY GETTING
MORE NEW MEMBERS

EIGHTH NATIONAL CERAMIC EXHIBITION PRIZE-WINNING PIECES

Viktor Schreckengost, Cleveland, Ohio: (1) Ceramic sculpture, "Shadrach, Meshach, Abednego"; an outstanding example of this sculptor's work in which he uses the clay itself and glazes to develop his negro figures. His theory is that clay and glaze should not exclude each other but that each material should be used to emphasize the other. (3) Ceramic sculpture, "Androcles and the Lion." His humor, combined with Bernard Shaw's (for Shaw's story comes immediately to mind) is irresistible. It is also sound sculpture, and it illustrates his belief that all angles of a piece should possess interest and surprise. Modeled directly in red clay with only part of the surface glazed, the work represents the slave removing the thorn from the lion's paw. Androcles, in a mottled brown outfit, leans over the lion in a most precarious position. The animal, in brown with a large wooly mane, has his eyes closed and his tongue sticking out in an anticipatory pose. (Not in competition.)

Annie Laurie Crawford, New York, N. Y.: (2) Ceramic sculpture, "Dancers Martinique," done in brown with bright blue-green glaze.

David Seyler, Cincinnati, Ohio: (4) Small clay, "Portrait of Jack Chasnoff"; an unusually sensitive piece, although somewhat fragile for ceramic sculpture and more reminis-



cent of fine porcelain ($50.00 Purchase Prize given by B. F. Drakenfeld & Co., New York, N. Y.; exhibiting for first time).

Thelma Frazier, Cleveland, Ohio: (5) "Small Fry" and (6) and (7) "Pegasi on Tracks"; amusing examples of Miss Frazier's work which show excellent sculptural qualities besides their whimsical notes. (8) "Night with the Young Moon," which possesses great dignity of form, color, and in the conception of the idea. Miss Frazier shows a perfect understanding of her medium and an appreciation of its great possibilities ($100 Purchase Prize for ceramic sculpture given by the Hanovia Chemical and Mfg. Co., Newark, N. J.).

Russell Barnett Aitken, New York, N. Y.: (9) Ceramic sculpture, "Quelques Fleurs"; negro boy with skunk, in clay and glaze. (Not in competition.)

Gertrud and Otto Natzler, Los Angeles, Calif.: (10) Pottery group composed of fruit bowl and smaller bowl in Pompeian turquoise glaze; vases with Pompeian earth and stone green glossy glazes; and two small ash-trays in blue and turquoise sea-wave glaze. Distinguished for thinness and fineness of throwing, usually more characteristic of porcelain. Beautiful in shape and proportion, interesting in the undeveloped state of surface quality, simple in form, and almost purely ornamental ($100 Purchase Prize given by the Onondaga Pottery Co., Syracuse, N. Y.; exhibiting for first time).

Viktor Schreckengost: (11) Four plates and a plaque from set of plates entitled "Baseball"; done in black on tan background with green border.

Glen Lukens, Los Angeles, Calif.: (12)(*a*) Large bowl in Death Valley raw yellow alkaline glaze (Award of Merit for Pottery).

Charles Harder, Alfred, N. Y.: (12)(*b*) Tall gray stoneware vase (Award of Merit for Pottery).

Don Schreckengost, Alfred, N. Y.: (13) Large plaque, "Cupid's Holiday."

Harold Riegger, Perry, N. Y.: (14) Brown stoneware unglazed bottle; complete in raw clay state (example of form and material belonging to each other); this work shows thorough feeling for the throwing of clay, and the ornamentation comes from the throwing itself ($100 Purchase Prize given by the Harshaw Chemical Co., Cleveland, Ohio).

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A Heap of Study and Unremitting Work Brings Success
A Faint Heart Never Achieves
He Succeeds Who Determines So to Do

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DEPARTMENT OF GLASS TECHNOLOGY UNIVERSITY OF SHEFFIELD, ENGLAND*

The Department of Glass Technology had its origin in the work of the University of Sheffield Scientific Advisory Committee set up in September, 1914, for the purpose of giving technical advice to manufacturers either in difficulties by the loss of supplies hitherto imported or about to embark on manufacturing much-needed new commodities.

The committee report emphasized that there was in this industry an almost entirely virgin field for service on the part of the University. The Council decided to make the venture, and in June, 1915, established the Department of Glass Technology. Dr. Turner was invited to act as organiser and before the opening of the new session in October, 1915, J. H. Davidson, was appointed the first lecturer.

Prior to this assurance of support from the industry, an approach had been made to the new Committee of the Privy Council for Scientific and Industrial Research which had been set up in 1915 for the purpose of giving more systematic support and encouragement to scientific and industrial research. The approach to that body was sympathetically received, and from it grants were obtained of £1500 for capital expenditure and £1200 per annum for five years for maintenance.

The Department of Scientific and Industrial Research, which was presently established and became the active agent for carrying out the policy of this Committee of the Privy Council, continued its help over a number of years and was especially helpful at one period of particular difficulty.

Through the kindness of W. Palmer Wynne, who gave all possible help to the new venture, accommodation was provided for the Department, consisting of a chemistry laboratory and of a room in the top storey where small-scale experimental melting could be begun. The funds provided by the Committee of the Privy Council and by the manufacturers made it possible to proceed to build on a site acquired for the purpose by the University behind the St. George's Square block of buildings of the Applied Science Department. There, a small building with frontage on Badger Lane and Thomas Street was erected in 1916 in which experimental glassmelting could be carried on. Other activities of the Department, involving the use of chemical and physical laboratories, were spread through other sections of the St. George's Square premises and those at Western Bank. The new premises were opened without any formality early in 1917. A considerable amount of work was done between 1917 and 1919 for the Ministry of Munitions (Optical Munitions and Glassware Supply), and the Ministry provided additional funds. One of the special developments undertaken on behalf of the Ministry of Munitions was a School for Lampworking, for the purpose of training girls and disabled soldiers in the art and craft of glassblowing for making all kinds of light-blown scientific apparatus. The School was continued until 1922, having sent out a large number of trained workers.

After the war, in 1919, the laboratories borrowed in various parts of the University were required to accommodate the great influx of ex-service students, and the Department of Glass Technology was consequently in serious difficulty for space. The remainder of the site at Badger Lane, on which it was intended that the Department should expand, was occupied by small cottage property, and the Rent Restrictions Act and the natural disinclination of the tenants to move created an extremely difficult situation. A solution of the problem, useful at the time though not a perfect one, was obtained by acquiring the empty premises in Darnall Road which had been occupied by a glass bottle works. An appeal to the glass industry for funds to permit of the acquisition of these premises was made, and a considerable sum was raised. After certain internal structural re-arrangements, the Darnall Road premises were entered for the purpose of normal work at the end of the summer of 1921. Although the surroundings were anything but those associated with University life and work, members of the staff made light of the lack of amenities and entered on a period of fruitful activity which greatly enhanced the reputation of the Department.

From the outset it had been the belief that, for the students' sake at least, the Darnall Road premises must not be regarded as other than a temporary home and that sooner or later premises must be found near one or other of the main University blocks of buildings. Over a period of years, several sets of plans for building were prepared, but no scheme promised success until in the autumn of 1935 the Elmfield site was discovered to be for sale. The members of the glass industry associated with the Depart-

* Material obtained from brochure issued by the University of Sheffield, June, 1939.

New Buildings, Department of Glass Technology, University of Sheffield, "Elmfield," Northumberland Road, Sheffield, 10.

ment work at once recognized it as almost an ideal site. In March, 1936, it was finally acquired and held until the funds could be provided for building operations.

The favourable opportunity for raising funds occurred later when, in October of the same year, the Department celebrated its Twenty-First Anniversary. A decision had been made to launch an appeal for £20,000 at the Anniversary luncheon, and almost the entire sum was announced at the end of the luncheon as having been received; the total to date is approximately double the amount initially asked for. By its enthusiasm and generosity, the glass industry has provided the fourth and permanent home for the Department of Glass Technology.

The work of the Department has been associated in the closest possible manner—indeed, in many ways a unique manner—with the industry it serves. From the outset in 1915, the co-operation of industrial representatives was sought. In 1916, the Committee of the Privy Council endorsed this attitude toward the industry and stipulated, in making its grants, that a special University body, owing responsibility direct only to the Council and having the title of the Glass Research Delegacy, should be set up for the purpose of administering under the Council all funds intended for the work of the Department of Glass Technology. This body and its various committees not only supervise the expenditure of moneys but also the general activities of the Department. The first Chairman of the Glass Research Delegacy was Sir Wm. E. Clegg; the second, Sir Albert J. Hobson; the third, W. F. J. Wood, C.B.E.; and the present Chairman is Stanley B. Bagley, F.S.G.T.

The Glass Research Delegacy is composed partly of University representatives, partly of industrial representatives. Glass manufacturing firms enjoy membership on condition that they pay an annual subscription bearing some relationship to their output. Under this scheme, the direct contributions from the industry toward the work of the Department in 1937–1938 amounted to £3610, and the amount is steadily rising. Practically all the important glassmaking firms of Great Britain are contributing members to the Delegacy. The Canadian and Australian glass manufacturers are likewise members. Comparatively recently, the title has been shortened to the "Glass Delegacy," the name which now appears in notices concerning this body.

The Department of Glass Technology was the pioneer institution of its kind in the world. No other institution of University rank had hitherto provided courses of instruction and facilities for research in glass technology, although in Austria and Germany three or four trade schools for the training of apprentices were in existence. The first institution of higher rank in Germany to provide such facilities was the Technische Hochschule at Karlsruhe, at the end of 1922. A number of institutions in America, Germany, and elsewhere have subsequently established facilities for teaching and research, but the Department of Glass Technology at Sheffield is still looked up to as the leader in progress in this field.

In 1916, arising initially out of several joint meetings of the Local Centre Course students held during the summer, Dr. Turner recognized the need for a scientific and technological Society and in November of that year the Society of Glass Technology was established with its headquarters in the Department. That Society quickly established an international reputation, organized international conferences from 1920 onward in the U. S. A., in France, Belgium, Germany, Italy, and Denmark and received return visits in other years. The Society has a membership of about 750 spread throughout twenty-nine countries. The actions and reactions of the Department and of the Society of Glass Technology have been extremely valuable to one another. The Glass Convention is a further institution which has grown out of the work of the Society of Glass Technology.

CERAMIC HISTORY

CLARA CHIPMAN NEWTON, PIONEER SECRETARY, ROOKWOOD POTTERY COMPANY*

"I have not lived a life in active touch with men and women without realizing that to believe a thing to be unjust is perhaps one of the hardest of life's burdens. I, therefore, long ago learned that within doing the work well we have to do lies its own reward, that nothing else should count."—C. C. N.

"Remember! If you once get sorry for yourself, you're done for!"—C. C. N.

Clara Chipman Newton, in her busy life of eighty-eight years, spanned the time from what has been called the "golden era" of American life, when the courage, initiative, and tenacity of the individual were of prime importance, into the highly organized postwar period when adaptability, the spirit of coöperation, and poise were most necessary.

She was born in the little town of Delphos, Ohio, in 1848, whither her father had moved from Vermont, but in 1852 the family settled in Cincinnati, where Mr. Newton engaged in business and was also interested in the cultural side of life.

In her girlhood, little Clara occupied a position which might have been akin to that of Cinderella, in a strangely assorted family consisting of her father, her own sister, a step-mother, a step-sister, and a half-brother. But she loved them all and helped them always, for she was doubly gifted both with artistic and business ability, and early learned to turn these faculties to account, so that from her 'teens on to the four-score mark, she was not only self-supporting but seems also to have taken as her life-text the lines, faded now, but so carefully written in her copy-book,

"Give strength, give thoughts, give deeds, give pelf,
Give love, give tears, and give thyself,
Give, give, be always giving,
To give not, is not living."

Her father died in 1871, and shortly thereafter the family scattered. Mrs. Newton went to Denver for the son's health, and Clara joined for a time the household of her step-sister, Annis Withenbury, in Glendale, near Cincinnati.

Miss Newton received her early education at Miss Appleton's school, an experience which she always treasured. The friendships formed at that time extended, in many cases, throughout her life and reached into many phases of her church and club interests. Without the

* From "Clara Chipman Newton, A Memorial Tribute," Cincinnati, Ohio, privately printed, 1938.

advantages of extended travel or additional formal training she never ceased to learn throughout her long life, studying wherever possible, and keenly alive to the latest developments of the times.

Not a woman of independent means, she maintained a downtown studio for many years, exhibiting, teaching, allying herself with groups for experimenting in new media, or promoting interest in the arts. The products of her skillful brush and pen were treasured in many Cincinnati homes. Her output must have been tremendous, judging by the lists of works exhibited or sold, but of how few artists can one truthfully chronicle, as of her, that almost nothing of her own production was found in her possession at the end of more than a half century of work? One of her larger productions, a vase with arabesque decoration under the glaze, was illustrated and described in Barber's History of the Pottery and Porcelain of the United States and is now in the Philadelphia Museum of Fine Arts.

During this period, Miss Newton taught the art classes for a number of years at the Thane Miller School. From 1901 to 1904, as recorded by Miss R. Jane DeVore, president of Glendale College, she "gave the instruction in the art department there, spending two days and the intervening night at the College."

In passing in review the art history of which Miss Newton was a moving spirit, one cannot fail to be struck by the way each organization developed out of its predecessor. The torch of progress was passed on from hand to hand. And all who knew Miss Newton—her unflagging interest, her broad point of view, her generous impulses, will recall that she was invariably one of the first to wish each new venture "Godspeed."

Cincinnati Pottery Club

"The Cincinnati Pottery Club was formed at the home of Miss Alice B. Holabird on April 1, 1879, of a limited number of women who were interested in decorating pottery. It has been said of this club that it was 'unique,' and in one respect, at all events, it could claim that designation, for during the more than sixteen years of its existence the officers chosen at the first meeting were reëlected every year. While the privilege of acting as president was mine, Miss Clara Newton was secretary, and Miss Alice Holabird, treasurer. Miss Newton was an ideal secretary, but it is hardly necessary to dwell on her ability in that direction because since that time she has filled the same exacting office in so many other organizations with preëminent success. Her fidelity and devotion to the interests of the Pottery Club were always evident throughout its existence. Perhaps interest in the work of this club was especially near to her heart, and it may be said that this organization did bear a part in the cultivation of appreciation of art in our city, for it is believed to be not only the oldest organization in the interest of ceramics in this country, but also one of the first women's clubs to be founded. The yearly reception given by the club, when the handiwork of the members was exhibited, was always thronged by an enthusiastic crowd of the leading citizens."

(*Signed*) *M. Louise McLaughlin*

The Chicago World's Fair

The Columbian Fair project was no small undertaking from any point of view, as one of the largest and most beautiful rooms in the Woman's Building, the Reception Room, had been assigned to Cincinnati, "the only city in the United States which has a room all by its little self at the World's Columbian Exposition." Miss Agnes Pitman worked for months in painting the frieze, and to Miss Newton was delegated the difficult task of arranging the exhibits in this room, bringing into beautiful harmony the pictures, sculpture, ceramics, wood carving, art needlework, and books which the women of Cincinnati had prepared. The funds for necessary expenses were raised by lectures, talks, readings, plays, concerts, musicals, tableaux, teas, etc., including the exhibition at the Lincoln Club of the work which was to be sent to Chicago, together with Henry F. Farny's paintings of Indian life. Miss Newton was chairman of this exhibition. Subscriptions, gifts, and guarantees were secured in addition.

Of equal importance was the vigorous newspaper campaign she waged to arouse interest in the venture. As secretary of the all-important Conference Committee, her pithy and humorous reports won the admiration even of the long-suffering reporter assigned to the job of covering its meetings. He described it thus, "It is the queen bee of the whole lump. It is made up of members of all the other committees. Each committee has its grist, then they lump it all and run it through the Conference Committee hopper. The Conference Committee is a terror. It grinds out stuff by the column—all good stuff; have to use it. And it gives the city editor a fit every time I bring it in. It is written so you can't cut anything out, and there you are... If I live to reach the World's Fair, it will be only to hunt a rug in a corner of the Cincinnati Room and lie down and die."

As always, her words were matched by her deeds, and in reading the charming papers she prepared at various times about all this work, those who knew her can picture her once more—tiny, round, trim, poised, with her fair skin pink with earnestness, her blue eyes sparkling, and her gay little laugh always ready as she worked, verily "with all her might." It might be in decorating those first Centennial teacups when she "with marvelous patience rubbed out, painted in, and rubbed out again to such an extent that I had two teacups to show as the result of the labor of three days a week for three months." It might be in the long and wearisome task of preparing the room at the Columbian Fair when she and her aids labored in unfamiliar, ill-equipped surroundings, cold and hungry. But always and invariably, in Miss Newton's accounts, the work takes on the romance of an adventure with interest and gaiety enough to outweigh the strain and the pain of it.

EARLY DAYS AT ROOKWOOD POTTERY*

My connection with Rookwood began in the spring of 1881. Mrs. Storer and I had been schoolfellows under the training of Miss Appleton. For the sake of the school days and because of our mutual love of the work we were engaged in, the tie between Mrs. Storer and myself never assumed the relation of employee and employer. Our deliberations as to ways and means would to an outsider have carried the conviction of equal financial interests. How clearly I remember the discussion of how we should

* By Clara Chipman Newton.

define my exact position and how pleased we were when we decided that "secretary" was a title that sounded impressive so far as the Pottery was concerned and to ourselves might be a sufficiently elastic term to cover the many-sided work that really came under my supervision. Later we congratulated ourselves upon the wisdom of our choice when the business began to grow and with it the correspondence that fell to my lot.

The Pottery in the early days was on the river bank near the point where the Little Miami railroad crosses Pearl Street.

Situated as it was near the railroad crossing, where each locomotive whistled and each passing streetcar drawn not too rapidly by the enduring mule rang its bell, it was not only noisy, but the dirt was appalling. Mrs. Storer, moreover, soon discovered that the quantity of clay used, though comparatively small, must be brought from Chattanooga by rail. She had had a vague idea that the pottery must be on the river in order to have numerous barges laden with clay conveniently near. Our first and only boat load of clay arrived at a time when the river had retired low into its bed leaving the Pottery high and dry so that the cost of hauling the clay from the boat was as much as it would have been from the railway station. Later we had other experiences with the capricious Ohio. Two winter floods inundated the lower part of the Pottery.

The first kiln was drawn in November, 1880. It was filled with pitchers, teapots, etc., of simple red and yellow clay and of pretty shapes, after the fashion of early Doulton wâre and with Mrs. Storer's decorated work.

In the summer of 1881, Mrs. Storer decided that, in order to carry on the work of the pottery satisfactorily, more room was required. Two frame buildings were added; the first floor of the one building facing the street was used as a storeroom. The north end of the upper room was fitted with tables and shelves for Mrs. Storer's use; my desk and belongings were in the south end of the room.

Mr. Joseph Bailey came to the Pottery in its second year and, except for a temporary absence, continued there until the time of his death.

Mr. Bailey had come from a family of potters and had worked as a boy in the English potteries. He knew his business from a practical standpoint most thoroughly.

The drawing of the kiln always brought our little circle together. Each one knew, or at least I knew, for I always went over the pottery, once and frequently three times each day, just what was in the kiln. If it was an experiment that was being tried, we were anxious to know the results. Even with ordinary decoration, one can never be sure that the unexpected may not happen; when it does happen and the happening is something so magnificent as the "Tiger Eve," choicest of Rookwood productions, the time and money spent over solving the mystery are as nothing to the brain power and patience required to guide experiments.

The commercial ventures of Rookwood began in the fall of 1880. Mr. Edward Atkinson of Boston came to Cincinnati on a lecture tour and was greatly interested to see the beginning of a new industry. The first pieces drawn from the kiln were sent to Buggs & Company of Boston to be shown by Mr. Atkinson at the lecture describing his western tour.

From the earliest days of its existence, Rookwood claimed public interest and had quantities of gratuitous advertising. The trying of such a project by a woman was not only new in our country but it had in it also an element of the picturesque. The story to be told found its way from papers to magazines without the least effort upon the part of Mrs. Storer.

In the fall of 1882, it was decided to introduce the work more generally to the Cincinnati public by opening exhibition rooms, such as one finds in the East. The parlors of a residence on East Fourth Street were fitted up with shelves and show cases. Duhme & Company were made the Cincinnati agents and were our generous patrons.

It was also in the fall of 1882 that the first effort was made to place the vases in Eastern cities. The attempt met with great success, several firms agreeing to handle the goods.

Both the financial and artistic success of the Pottery has been acquired under the able management of Mr. W. W. Taylor. To Mr. Taylor is due the honor of carrying the Pottery up from the mud banks of the river to the heights of Mt. Adams.

THE PORCELAIN LEAGUE OF CINCINNATI*

By Clara Chipman Newton

In the spring of 1878, Miss McLaughlin conceived the idea of forming a ceramic club. Twelve ladies met at the home of Miss Holabird. They were Miss McLaughlin, Mrs. E. G. Leonard, Mrs. A. B. Merriam, Mrs. George Dominick, Miss Edna Fletcher, Miss Holabird, Miss Laura Fry, and Mrs. Plimpton. The organization was made and named The Cincinnati Pottery Club; Miss McLaughlin, President; Miss Newton, Secretary; and Miss Holabird, Treasurer.

Mr. McKinley in Buffalo said in his last address, "Expositions are the timekeepers of Progress." I feel this to have proved itself true in its bearing upon the work of women in Cincinnati.

It was after the Centennial of 1876 that the women of our Centennial Exposition Board launched the movement which gave us our Art Museum. It was also from the impetus given at the Philadelphia Centennial to the original and artistic mind of Miss Louise McLaughlin that pottery painting was undertaken here. The first work of this kind ever exhibited in Cincinnati was a vase decorated by Miss McLaughlin and shown at the Loan Collection under the auspices of the Women's Art Museum Association for the fund which was raised toward a museum.

I have no hesitation in saying that this was the first Ceramic Club in this country and the one that served as a model for those which were formed later in other cities. I also think that it must have been one of the earliest of the women's clubs, which are now such powerful factors in all directions. Decorative art rooms about this time had

* Extracts from paper read at the Porcelain League Breakfast in honor of its twentieth birthday, January 10, 1914. Material obtained from the Historical and Philosophical Society of Ohio, March 10, 1939.

begun to take shape in other cities. Our leading women opened one here in a two-story building which stood upon the present site of the Methodist Book Concern. The rooms were in the second floor; the sales rooms were in front. The Pottery Club rented the back room and started its career. All our vases had to be transported from the Dallas Pottery.

We very early realized that this was too heavy a handicap, so after due consideration we rented a room at the Dallas Pottery. This room was over the sheds where the pottery was stacked. We had the enthusiasm of youth to bring to our experiments and, strange to relate, for once in the history of Cincinnati our public was with us. I remember going one day to the rooms, and as I opened the door I saw Miss McLaughlin standing on a table applying clay with a huge brush to the largest vase I had ever seen. I was still young enough to have an intimate touch with the Arabian Nights so exclaimed, "Why, Louise, that's an Ali Baba vase." Ali Baba it became and is still.

There we had our first Pottery Club exhibit. The whitewashed walls were hung with rugs as a background to the masses of dogwood and other fresh blooms. The invitations, very limited in number and artistically designed by Miss McLaughlin, were accepted by the favored few and were requested by numbers of people who had been, from limitation of space, omitted from our lists. Throughout the appointed hours, crowds surged up and down the old wooden stairway, in and out of the kiln sheds which were also in gala array.

In the middle of the afternoon, old Mr. Dallas, full of excitement, came to a small group of us to tell us that carriages were standing as far as you could see up and down the street and way around the corner. Those carriages were to him the outer and visible expression of reward and spiritual grace he had previously doubted the members of the club possessing. Perhaps he had his reasons for the doubt, as he saw many ruins of our work. Naturally our work had to take its chances in kilns full of commercial ware with the commercial ware having first consideration.

Mrs. Storer, then Mrs. Nichols, with Mrs. William Dodd and several other ladies, worked in another part of the pottery. They too felt the limitations so great that Mrs. Storer had a small overglaze kiln built and Miss McLaughlin, an underglaze kiln, which all workers in the decorative field were allowed to use, the cost of the firing going to the Pottery.

The Pottery Club occupied these rooms for about three years when Mrs. Nichols started the Rookwood Pottery. She took with her the men who had been the most helpful to us; young Joe Bailey, as he was called to distinguish him from his father, and Mr. Auckland, the man who made the ware on the wheel. At this period, the old kick wheel was used.

We had three receptions at the Dallas Pottery and then gave up our rooms to go to Rookwood. We had a room there for several years until commercial conditions made it advisable for Rookwood to give up outside work. We might send for ware, but transporting it proved a very risky business and was gradually given up. In the last exhibitions made by the Club, there was a great deal of overglaze decoration and much of it was very creditable. It is true that the designs did not follow the present-day canons covering correct decorative principles, but they were wonderfully good of their kind.

The Pottery Club existed as an active organization for eleven years. In 1891–1892, we reorganized in order to make an exhibit in the Cincinnati Room at the Columbian Exposition in Chicago. This last exhibit, 1893, was really very beautiful and creditable. Perhaps the Columbian Exposition was a fitting port in which to anchor the good ship, "Cincinnati Pottery Club." The ripples the vessel had made had broadened into a great and far-reaching circle which had more influence than we realized possible over the ceramic art of the country. There is no recent history of ceramics in the United States that does not give it a place in its pages. Special artists represented the *Harper's Weekly* at our first two or three exhibits, and in the old files of this paper may be found photographs and descriptions of the work.

During our career, an exhibit was sent and was favorably received in London. Miss Holabird had the experience of her artistic life when the report came that the Prince of Wales (the late King Edward) had expressed his approval of one of her vases.

One of the notable events, outside of the annual receptions that we held, was a breakfast at the Queen City Club where we exchanged plates.

The next link, historically in this chain, is the Rookwood Pottery, but that is not a link relative to this subject.*

The Porcelain League

Twenty years ago, the tenth of January, 1894, some members of the old Pottery Club and some of the more recent of the china decorators met by invitation in Miss Holabird's apartment to complete an organization planned by Mrs. Field and Miss Fry. By unanimous vote, the name "Porcelain League" proposed by Miss Holabird was decided upon. Experience in the Pottery Club had taught us the wisdom of adopting some specified study as a working plan. This departure from the old order would, we thought, hold us together, and in accordance with the original plan there has always been a "motif" for work given out at each meeting for the succeeding meeting.

Mrs. Field was our first president; Miss Holabird the first treasurer. The records of these meetings were not very profuse, so there is little to guide one in writing their history, and my touch with the Porcelain League has not been personal enough in attendance at consecutive meetings to make a chronicle as complete as the subject requires.

Handicraft League

Our various presidents have stood sponsors for many activities in the art life of the city. Mrs. Walter Field served as president of the Handicraft League, an organization that was fostered and supported by the Porcelain League. The Porcelain League has done much to establish the arts and crafts movement. Our members are largely represented in the Executive Board of the Crafter's Company, and those who are not so represented have generously given their services to the Shop Committee.

* For other accounts of the work of Mary Louise McLaughlin, Laura Anne Fry, Clara Chipman Newton, Maria Longworth Storer, and the founding of Rookwood Pottery, the following *Bulletin* references are given: **11** [6] 152 (1932); **15** [12] 443 (1936); **17** [5] 217 (1938); **17** [9] 368 (1938).

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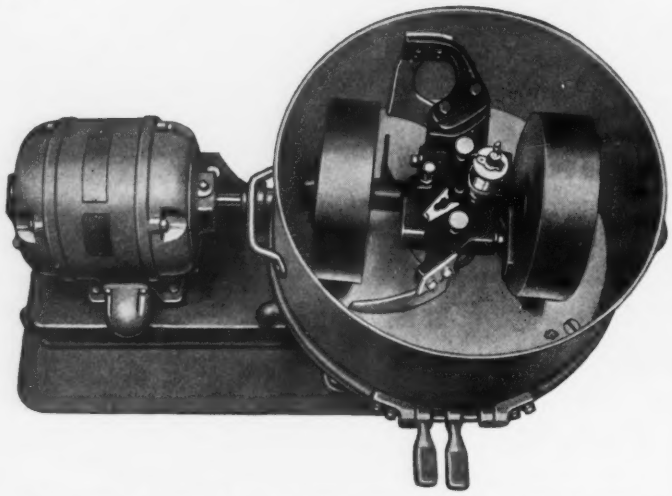

Laboratory size Simpson Intensive Mixer, equipped with removable crib, crosshead and mullers. The standard machine for test and control work on ceramic and refractory materials.

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Harshaw Chemical Co.
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Maxson, Elwyn L.
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Spinks, H. C., Clay Co.
United Clay Mines Corp.

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Potters Supply Co.
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United Clay Mines Corp.

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United Clay Mines Corp.

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United Clay Mines Corp.

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Spinks, H. C., Clay Co.
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Pennsylvania Salt Mfg. Co.

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Harshaw Chemical Co.
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The Vitro Mfg. Co.

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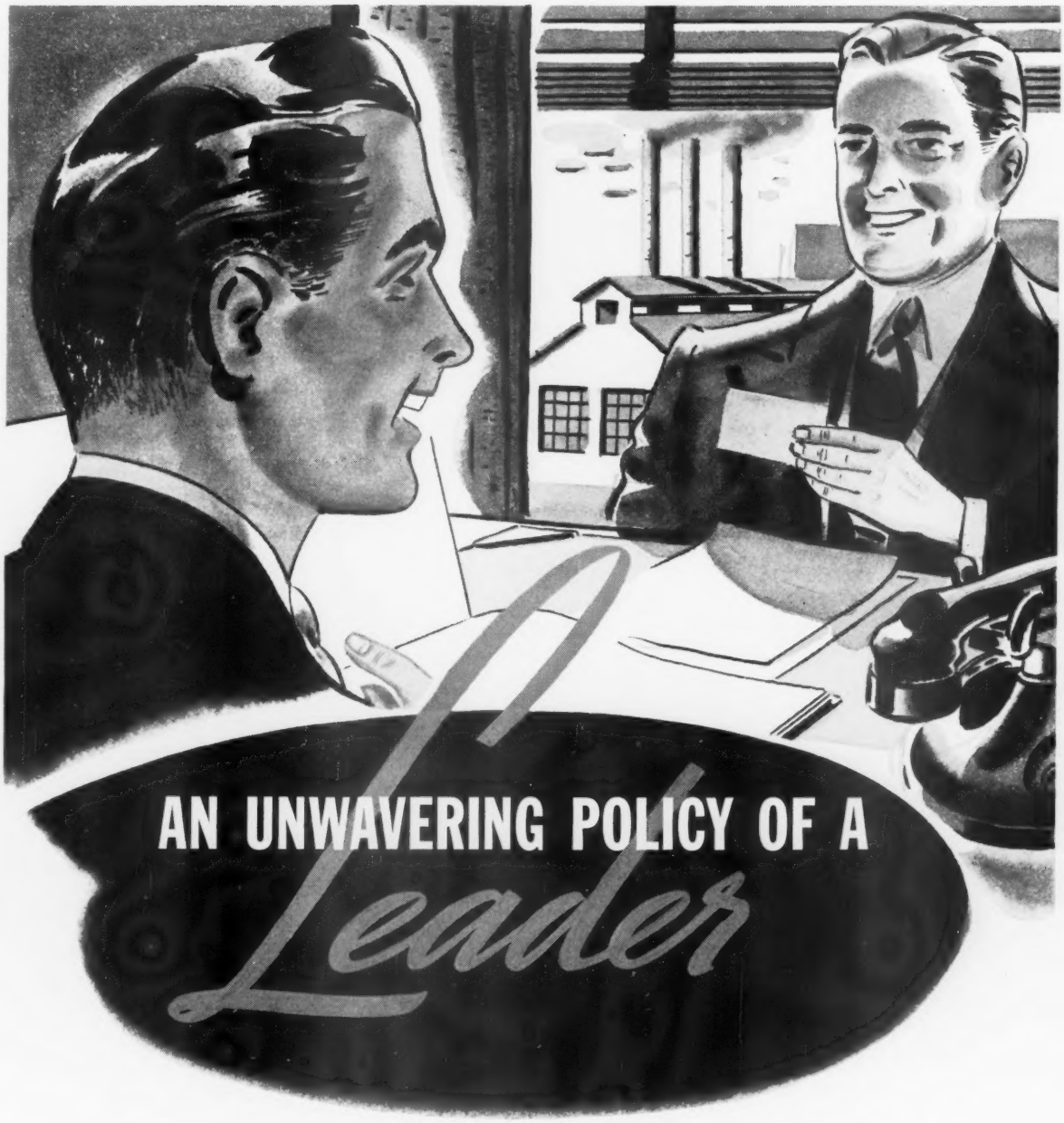

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Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Hoppers (Floor, Tower)
Ransome Concrete Machinery Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Hydrofluoric Acid
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Iron Chromite
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kilns, China (Decorating)
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Kilns- (Electric, Circular, Tunnel)
Swindell-Dressler Corp.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide) (Refractory)
Louthan Mfg. Co.

Kyanite
Celo Mines, Inc.

Kryolith (see Cryolite)
Pennsylvania Salt Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Lehrs
Frazier-Simplex, Inc.
Swindell-Dressler Corp

Lehrs (Electric or Fuel Heated)
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehr Loaders
Frazier-Simplex, Inc.

Linings (Furnace Refractory, Block Refractory Plate, Brick, and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.
The Vitro Mfg. Co.

Lithium Carbonate
Drakenfeld, B. F., & Co.
Edgar Plastic Kaolin Co.
Foote Mineral Co.

Lithium Minerals
Foote Mineral Co.

Loaders (Bucket)
National Engineering Co.

Magnesia (Fused)
Norton Co.

Magnesia (Sintered, Calcined)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Magnesite Calcined
Foote Mineral Co.
The Hommel Co., O., Inc.

Magnesium Carbonate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese Dioxide
Drakenfeld, B. F., & Co.
Edgar Plastic Kaolin Co.
Foote Mineral Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Masks (Breathing)
The DeVilbiss Co.
Drakenfeld, B. F., & Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Micronized Products
Porcelain Enamel and Mfg. Co

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers
National Engineering Co.
Ransome Concrete Machinery Co.

Mixers (Batch)
Lancaster Iron Works, Inc.
National Engineering Co.

Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)
Lancaster Iron Works, Inc.
Ransome Concrete Machinery Co.

Mixers (Laboratory)
Lancaster Iron Works, Inc.
National Engineering Co.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace) (Laboratory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Frazier-Simplex, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

Mullers (Batch)
Lancaster Iron Works, Inc.
National Engineering Co.

Muriatic Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Needle Antimony
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nepheline Syenite
Great Lakes Foundry Sand Co.

Nickel Salts
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Nitre
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Louthan Mfg. Co.
Potters Supply Co.

Pins (Tile Setter)
Louthan Mfg. Co.

Placers (Concrete Pneumatic)
Ransome Concrete Machinery Co.

Placing Sand
Great Lakes Foundry Sand Co.
United Clay Mines Co.

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Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Polariscopes
Bausch & Lomb Optical Co.
Frazier-Simplex, Inc.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.

The Vitro Mfg. Co.

Potters Wheels
Denver Fire Clay Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Frazier-Simplex, Inc.

Pug Mills
Lancaster Iron Works, Inc.

Pyrites (Natural Iron Sulphide)
Foote Mineral Co.
The Hommel Co., O., Inc.

Pyrometer Tubes
Carborundum Co.
Montgomery Porcelain Products Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.

Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation

Racks, Firing (Refractory)
Louthan Mfg. Co.

Raw Material Handling Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

Refractometers
Bausch & Lomb Optical Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.

Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.
Titanium Alloy & Mfg. Co.

Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Foote Mineral Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal and Thermit Corp.
Titanium Alloy & Mfg Co.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Salt Cake
American Potash & Chemical Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Sandblast Sand
Great Lakes Foundry Sand Co.

Sand Grinder and Sifters
Lancaster Iron Works, Inc.

Saponin
The Hommel Co., O., Inc.

Screening and Magnetic Separators
National Engineering Co.

Selenite of Sodium
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Setters (Tableware)
Louthan Mfg. Co.

Sheaves (Tower)
Ransome Concrete Machinery Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
Edgar Plastic Kaolin Co.
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Silicon Carbide
Carborundum Co
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Denver Fire Clay Co.

Slabs (Furnace)
Carborundum Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sodium Metasilicate
Harshaw Chemical Co

Sodium Nitrite
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Uranate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Soot Blowers
Frazier-Simplex, Inc.

Special Machines
Frazier-Simplex, Inc.

Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Spray Booths
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spraying Equipment
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spurs
Louthan Mfg. Co.
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Stilts
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Tanks
Frazier-Simplex, Inc.

Tank Blocks
Corhart Refractories Co.

Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Tile (Floor)
Norton Co.

Tile (Muffle)
Carborundum Co.
Norton Co.

Tile Setter Pins
Louthan Mfg. Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Norton Co.

Tile (Wall)
Denver Fire Clay Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co

Towers (Concrete, Concrete Elevating, Steel Elevating)
Ransome Concrete Machinery Co.

Trisodium Phosphate
Harshaw Chemical Co.

Trucks
Lancaster Iron Works, Inc.

Tubes (Insulating)
Carborundum Co.
Louthan Mfg. Co.
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Uranium Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Uranium Oxide (Yellow-Orange-Black)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Water Softening Plants
Frazier-Simplex, Inc.

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Winding Drums
Lancaster Iron Works, Inc.

Zinc Oxide
Ceramic Color & Chemical Mfg. Co
Du Pont de Nemours, E. I., & Co. Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Zircon
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel Co., O., Inc.

Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Zirconium Oxide
Foote Mineral Co.
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Zirkite (Natural ZrO_2)
Foote Mineral Co.

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Antimony Oxide
Antimony, Black Needle
Barium Carbonate
Barium Chromate
Bone Ash
Cadmium Carbonate
Cadmium Oxide
Cadmium Sulphide
Calcspar
Chrome Oxide, Green
Clay, Vallendar
Cobalt Oxide, Black
Cobalt Sulphate
Copper Oxides
Iron Chromate
Iron Oxides
Kryolith
Lead Chromate
Magnesium Carbonate
Manganese Dioxide
Nickel Oxide, Black
Nickel Oxide, Gray
Nickel Sulphate
Potassium Bichromate
Potassium Nitrate
Potassium Permanganate
Powder Blue
Rutile, Powdered
Selenium
Sodium Aluminate
Sodium Antimonate
Sodium Bichromate
Sodium Silicate
Sodium Silico Fluoride
Sodium Uranate
Tin Oxide
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Uranium Oxide, Orange
Uranium Oxide, Yellow
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NEWPORT, KY.

November 1, 1939

Mr. Pete Potter
Comfortable Sanitary Pottery Mfg. Company
Pottsville, Ohio

Dear Pete:

No war today—back to the mines and the "pot shops."

The people are to have plenty of circuses. The 1940 World's Fair is to be "The Biggest Show on Earth." Stadiums have been built for the people in every part of the land. Go to games and see Goldberg carry the ball 'til he gets stopped by Luckman. You will find me in the top of the stands—never can tell when they will make an aerial attack.

If you don't think the Poles are still fighting and that the Italians are in the war, read the names of a few Pennsylvania High School line-ups.

Pretty good show they are putting on in Washington.

Yes, they have "blacked out" the Pittsburgh district, but I found the people do not complain and are glad to see the potteries and the mills roll out the smoke.

Yes, we are very busy, Pete, but we are just as appreciative as ever of your business and will continue to promptly ship uniform, clean, dry **BALL CLAY**.

Sincerely,

Dick Carothers

General Manager

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